VOLUME LXIX NUMBER 1

INDIAN FORESTER

JANUARY, 1943

THE CURRIE SCHOLARSHIP FOR INDIAN FOREST STUDENTS

By E. C. Mobbs, I.F.S.

The Currie Scholarship originated in July 1887, when on the occasion of the distribution of prizes at Cooper's Hill College in England, Mr. B. W. Currie, who was then the Vice-President of the Council of India, made a personal gift of £1,000 of $3\frac{1}{2}\%$ India Stock in response to a plea by the President of the College for an increase in the number of scholarships available to its students.

In 1906 when that College closed down, it was decided after consultation with Mr. L. Currie that the scholarship should be awarded to the probationer who headed the list at the final examination prior to appointment to the Indian Forest Service. This scheme was followed till 1927, and as the income of the Charity increased, the scholarship took the form of a prize of £50 to the Indian Forest Service probationer heading the list of his year.

With the cessation of the training of I.F.S. recruits in England, the awards temporarily ceased, but with the introduction of training in India at the Indian Forest Service College at Dehra Dun, the scheme was varied by the Board of Education in 1930 and the prize was divided into two, £25 being awarded to a probationer for Burma trained in England and £25 to an I.F.S. probationer trained at Dehra Dun. As that College closed in 1932, and recruitment to the Indian Forest Service was suspended, the prize for 1933 was awarded to two probationers to the Burma Forest Service (B. E. Symthies and U. Tun Kyaw), both trained at Oxford, and each receiving £25. The following year, 1934, one prize of £25 was awarded to a probationer to the Burma Forest Service (C. B. Dix) and another of the same amount to a probationer to the Bombay Forest Service Class I (R. R. Chaudhuri), while in 1936 two prizes, again of £25 each, were awarded to two Bombay Forest Service Class I probationers (J. V. Karamchandani and Hari Singh).

Owing to cessation of recruitment, no awards were made in 1937, 1938 and 1939. Also, owing to the final separation of Burma from India and to the complete cessation of recruitment to the Indian Forest Service, consequent on the transfer of "Forests" to Provincial control, modifications in the scheme for administration of the scholarship became necessary.

The scheme was, therefore, reorganised in 1940 and under order of the Chancery Division of the High Court of Justice now provides that three-quarters of the net income shall be applied in the award of one or more annual prizes to candidates appointed to the Forest Services of India, and one quarter in the award of one or more annual prizes to candidates appointed to the Forest Services of Burma. The awards may be in such manner as the Trustees think fit. So far as the Indian portion is concerned, the Secretary of State for India has approved the award of the prizes to students of the Indian Forest College and has ordered that candidates trained for the Superior Forest Services of Indian States should be regarded as eligible under the scheme, as well as candidates for the Provincial Services.

As the course at the Indian Forest College extends over two years, and under the present organization there is a biennial intake, each class completing its course before a new class is admitted, the award of prizes has been made biennially, the amount of the prizes for India for the two years being divided in the ratio of 60 and 40 per cent. between the students standing first and second in the class. So far the following awards have been made:

1938-40 *Class*

1st Prize (£45) to Mohammad Habib Khan (Kashmir State), B.Sc., Honours diploma of the Indian Forest College.

2nd Prize (£30) to Raghubir Chand Soni (United Provinces), M.A. (Cantab.), B.Sc. Honours diploma of the Indian Forest College.

1940-42 Class

1st Prize (£45) to Kailash Chandra Jain (United Provinces), M.Sc., Honours diploma of the Indian Forest College.

2nd Prize (£30) to Mohan Lal Mehta (Kashmir State), M.Sc., Diploma of the Indian Forest College.

THE FORESTS OF RAMDURG STATE (DECCAN)

BY KADAMBI KRISHNASWAMY, D.SC., DIP. IN FORESTRY,

Working Plan Officer in Mysore.

General.—The information contained in this article has been extracted from a comprehensive report submitted by the author to the Ramdurg Durbar during August 1941, while on a three weeks' deputation from Mysore to Ramdurg State for inspecting its forests and suggesting measures for their silvicultural and economic improvement.

Forest growth in Ramdurg is of the dry-deciduous type, but it contains certain valuable woods and plays, in addition, an important role in national economy by supplying two indispensable wants of the local population, namely firewood and grazing. The conservative management of such forests is, therefore, a problem with which many foresters in India have to deal.

Situation.—Ramdurg is one of the smaller Indian States belonging to Kolhapur States Agency. It is bounded by the British Indian Districts Belgaum, Dharwar, Bijapur and the Kolhapur State, and lies between 15°—52′ and 16°—0′ north latitudes and 75°—16′ and 75°—26′ east longitudes.

The bulk of the area is compact and lies on either side of the perennial river Malaprabha, which flows through the State. The other smaller bits are situated at distances varying from 10 to 25 miles from Ramdurg town, to its north-west, north-east, east and south-east respectively. The eastern and south-eastern villages are interlaced with those of Bijapur and Dharwar collectorates of the Bombay Presidency.

Ruler.—The State is ruled by Shrimant Rajahsaheb Ramarao Maharaj of Ramdurg, an enlightened prince with a progressive outlook. He is assisted by an able Dewan, a retired officer of Mysore State Service with long administrative experience. Ramdurg town is the capital of the Rajah and the seat of his Government.

Area.—The area of Ramdurg State, excluding its *inam* villages, is 105,661 acres. Forest land covers about 16.4 per cent.

Geology—rock and soil.—The underlying rock is generally sandstone of the Kaladgi series. Quartz reefs are seen generally on ridges and hill tops. Laterite is superimposed in the eastern portions of the State, especially along the Badami road and in the Hoskeri group of villages.

On ridges and elevations the soil consists of red loam which, but for its shallowness and the heavy admixture of quartz pebbles, would have supported a much better kind of forest than the one it now has. In valleys, generally, there is black cotton soil, which varies in fertility from place to place with its varying calcium content. The steeper hill slopes have generally no useful soil owing to the washout but the gentler, lower slopes have fairly deep soil and are usually fertile.

Configuration of the ground.—Relatively low, flat-topped hills, interspersed by broad, level ground or shallow valleys characterise the landscape. The hills rise often abruptly to heights of about 500 feet from the general level of the plateau which stands about 1,900 feet high. One large coherent group of hills is situated to the south of Ramdurg town and the river Malaprabha. The valleys of this group of hills contain the best wooded portions of the State. The altitude of the country varies between 1,850 and 2,400 feet.

Climate and rainfall.—The climate is dry and healthy. Summer is very hot and winter fairly cool, the upper and lower extremes being about 110° F and 57° F respectively.

Rainfall is generally inadequate and unreliable. The average of the years 1931 to 1941 was 23.84 inches in Ramdurg and 22.73 inches at Sureban. Its monthly distribution is subject to considerable fluctuation from year to year; the rainiest months are generally September and October, but June and July are also fairly wet.

Forest produce in demand.—The chief demand is for grazing, firewood, small timber and stones.

All cattle, sheep and goats resort to forest grazing. Cattle grazing is free. Fuel from the coupes finds a market chiefly in Ramdurg town. It is removed generally after conversion into charcoal. Dry fuel is also removed by head loads.

Agricultural crops.—Wheat, *sajja* and cotton are chiefly grown.

The forest.—The growth type is "dry-deciduous". Pronouncedly xerophytic species predominate in the growth. The forest is patchy and open on hill-tops and ridges. In sheltered valleys trees generally grow close together to form a coherent forest canopy.

The principal woods are *Albizzia amara* (*tugli*), *Chloroxylon swietenia* (*meshwal*) and *Wrightia tinctoria* (*halagatti*). Their associate species are *Acacia spp., melia azadirachta* (*nim*), *Anogeissus latifolia* (*dindal*), *Abizzia lebbek* (*shirsal*), *Zizyphus jujuba* (*bari*), etc.

The commonest shrubs filling up the space in between the tree growth are *Mundulea suberosa* (*bandati*), *Dodonea viscosa* (*bandorabi*) and *Cassia auriculata* (*tarawad*). There are at least four species of Succulent *Euphorbias*, The *cactus, Opuntia dilleni* (*mulagolaki*), said to have been very abundant a few years ago, has now almost disappeared. Some of the rare species are *Sapindus trifoliatus* (*rita*), *Dolichandrone crispa* (*uruvai*), and *D. falcata* (*uruvai*).

The tree species *Ailanthes excelsa* (*Helubevu*) and *Salvodera persica* (*goinmara, pillu*) are usually found scattered outside forest lands; the latter generally near villages. Other trees associated with human habitations are mango, *tamarindus indica* (*chinch*), *Agele marmelos* (*bilpathri*), *Feronia elephantum* (*balolugida*), *Anona reticulata* (*ramphal*), *Anona squamosa* (*sitaphal*) and *Eugenia jambolana* (*jamoon*).

Certain species are confined to particular, often edaphically circumscribed, localities. Among them is *Acacia arabica,* found nearly gregariously on stiff, poorly drained soil along Malaprabha river. A few species are associated with the courses of streams, dry or wet. Among them are *Alangium lamarckii* (*ankola*), *Pongamia glabra* (*karanj, hulugli*), *Eugenia corymbosa* (*nai-neral*) and *Terminalia arjuna* (*bili-mathi*). The first is generally found along dry streams only. The tree *Stephegyne parvifolia* (*kobarichakke*) is occasionally seen in the Magadorabi-koll valley.

Sandal (*chandan*) is indigenous and occurs scattered in many places. The tree, when found, is usually confined to the banks of

dry forest streams or to fertile, sheltered valleys. It is, also, occasionally found in occupied lands, where it was probably artificially introduced.

Growth qualities and tree associations.—Two growth qualities are recognizable; (1) a superior, in which *Albizzia amara* is the principal species, and this is associated with *Chloroxylon swietenia* and *Wrightia tinctoria* and (2) and inferior from which *Albizzia amara* is nearly absent.

The superior growth quality.—The trees, especially those of *Albizzia amara* and *Chloroxylm swietenia,* develop full, round-headed crowns and they stand sufficiently close together to form a more or less coherent forest canopy casting some shade on the soil. The principal member of the undergrowth is *Mundulea suberosa.* There is some grass on the soil, which consists usually of rich, red loam.

The inferior growth quality.—This is characterised by the relative rarity, if not absence, of *Albizzia amara,* absence of a coherent forest canopy and relative increase of the succulent *Euphorbias,* and *Dodonea viscosa.* The soil is generally rocky with pebbles of quartz or outcrop of sandstone. There is little grass. The chief tree species is *Chloroxylm swietenia.*

Tree associations.—Three, more or less distinct, associations are noticeable:

(1) *Albizzia—Chloroxylon* association.—Consisting of *Albizzia amara* and *Chloroxylon swietenia,* mixed with more or less *Wrightia tinctoria.* The undergrowth is *Mundulea suberosa,* and this is sometimes associated with *Dichrostachys cinerea.*

(2) *The Wrightia—Chloroxylon* association.—This contains chiefly *Wrightia tinctoria* and *Chloroxylon swietenia,* and little or no *Albizzia amara.* The undergrowth is chiefly *Dodonea viscosa.*

(3) *Acacia arabica* association.—This contains chiefly *Acacia arabica.* There is little or no undergrowth. Soil cover is tufted, heavy grass.

This is an edaphic variant on associations 1 and 2 above.

Forest settlement.—The State contains about 17,383 acres of forest land, in which the people enjoy rights of grazing subject to payment of the prescribed fees. It has been recently proposed to place about 5,774 acres, containing forest of the best growth quality

and hitherto least interfered with by man, under special protection by declaring it "reserved" under section 20 of the Indian Forest Act. The remaining forest area has been proposed to be declared "Protected Forest", under section 29 of the Act.

Proposed measures for protecting the forest growth in the Reserve

(*a*) *Grazing restrictions.*—The reserve will be closed to grazing except during years of general drought and fodder scarcity.

(*b*) *Fire protection.*—An exterior fire line, 33 feet wide, will be cut all round the area, recleared annually and kept free from inflammable material. Cairned numeral stone pillars will be erected all along the boundary at salient points.

Proposed protection to certain trees and shrubs in the "Protected forest".—The following trees, etc. will be declared protected, their cutting or removal requiring special permits.

(1)	*Shirsal.*	*Albizzia lebbek.*
(2)	*Kobari-chakke.*	*Stephegyne parvifolia.*
(3)	*Nim.*	*Melia azarichta.*
(4)	*Hunase, chinch.*	*Tamarindus indica.*
(5)	*Hulagali, karanj.*	*Pongamia glabra.*
(6)	Small bamboo.	*Dendrocalamus strictus.*
(7)	Big bamboo.	*Bambusa arundinacea.*

Sandal is a royal tree in the State and enjoys special protection. It has been proposed to tighten the watch and ward as regards this species.

Proposed silvicultural treatment.—The whole forest will be worked under the "Simple Coppice System", with a rotation of 30 years. The fellings will be controlled by area. The felling rules prohibit the cutting of sandal and other economic species like *nim, mango, jamoon, chinch, karanj, tarawad bava* and *tumri* and of other rare species like *shirsal, kobarichakke* and *bamboo,* whose growth it is proposed to specially foster.

Supplementary silvicultural measures proposed are the artificial restocking of gaps caused by firewood fellings, with species suitable for the locality, propagation of sandal and soapnut by dibbling, and closure of the coupes to grazing for at least three years after each felling.

Forest nursery.—The opening of a central forest nursery adjoining one of the sources of perennial water to rear planting material for transplanting in forests and for supplying plants of useful species to the villagers for raising tree groups (*tope*) near villages has been proposed. The possible sites are:

(1) Ramathirtha near Mullur.
(2) Huvinkolla.
(3) Mogadorabi kolla.
(4) S. No. 206 of Halagathi village near the river Malaprabha.

Forest Staff.—This consists of a range forest officer, who is a part-time man and takes orders directly from the head of the general administration namely, the Dewan. The Range Officer has four subordinates namely one round guard and three guards.

Economic resources of the forests.—The major items of forest revenue are grazing, firewood (including timber and bamboo), quarries and tanning bark.

Grazing.—Grazing brings 60 to 70 per cent. of the income, and the *ryot* depends chiefly upon it for its existence, next to agriculture. By taking up the formation of *ficus* groves, prevention of lopping and introducing fodder trees fit for dry localities into the forests, the grazing revenue of the State could be improved, because forest areas round about the State have been impoverished of fodder through overgrazing and reckless lopping.

Firewood, timber and bamboo.—These are getting scarce, and measures are therefore required for conserving and improving the existing resources. It has been recommended that the growth of suitable local species like *Albizzia-amara, A. lebbek* and *Chloroxylon swietenia* be encouraged and that fast growing exotic fuel species like *Eucalyptus robusta, E. citriodora* and *Cassia siamea* be introduced.

It has also been suggested that the bamboos, *Dendro calamus strictus* and *Bambusa arundinacea* be introduced artificially along the river Malaprabha and the major streams as they would add considerably to forest revenue in a short time.

The encouragement of the local timber species *Albizzia lebbek,* and the introduction of others like *Albizzia odoratissima, Pterocarpus marsupuim, P. santalinus* and *Terminalia tomentosa,* the

last one on the stiff, heavy soils sometimes found along the river Malaprabha, have also been suggested.

Economic species.—The propagation of *Anacardium occidentale* (cashew-nut) and Soapnut, which are likely to do well locally, the former on red loam and the latter along all periodically dry streams, has been recommended.

Industrial resources of the forests.—Among industries which could be thought of in connection with the raw products which the forests contain, the following has been suggested:

The forests contain enough wood of *Wrightia tinctoria* (*halagathi*), to be able to support a reasonably large toy industry in the State. This wood is white, even-grained and suitable for turning, carving and for domestic utensils. It is largely used for making toys in Mysore State.

Meshval (Chloroxylon swietenia) the satin-wood of South India.—Is a very common tree of the forests and one which thrives considerably well. Its wood will probably be found suitable for bobbins. This wood is, in addition, a good constructional timber. The industrial possibilities of the local wood require further examination.

The woods of *Ailanthes excelsa* and *Salvodera persica* will probably be found useful in the manufacture of matches, but they are not available in commercial quantities. *Acacia arabica* wood is available in considerable quantity, and this should be able to support cartwheel manufacture as a good cottage industry in the State. The wood of *Grewia salvifolia* (*ulpi*) will probably be found suitable for walking sticks, and this could flourish either as an independent cottage industry or along with the central toy industry, if one be established. Small but lucrative uses could also be found for the dried and powdered leaf of *tugli* (*Albizzia amara*) the oil seed of *karanj* (*Pongamia glabra*) and the leaf manure of the latter species. The chemical constituents and medicinal properties, if any, of the wood liquor of *imti* (*Capparis aphylla*), which is common in the State are also worth investigating.

Need for tree planting on the countryside.—The climate of Ramdurg State is very hot in summer and moderately cool in winter. In the hot season the temperature soars up to about 110°F,

while in the cold season it touches 57°F. The rocky hills absorb heat by day, readily radiate it and make the afternoon hours very uncomfortable. The rapid evaporation resulting from these high temperatures makes the rainfall, which is already meagre, less effective and useful to plant life. Owing to want of adequate soil cover the sun's heat is readily absorbed by the hills and the land surface. The countryside is practically devoid of tree growth and, near many villages, there is hardly a shade tree. Even the common *pipal* (*Ficus religiosa*), grown near hamlets in many other parts of India, is absent here. There being no tree growth, the winds rush unimpeded across the bare plains by night and day at great velocity and add to the rapidity of the evaporation already severe owing to the high heat.

The sweeping winds scouring the treeless countryside carry with them fine sand off the sandy loam and deposit it along the margins of cultivation and edges of forest growth to form sand-blows. The *ryot* has thus been slowly, but surely, losing, in some places, his cultivable land, and in others the edge of forest growth is being gradually pushed back. This threat to the area brought under the plough has to be prevented before it attains larger proportions by introducing some suitable sand-binding hedge plants. One of the most suitable for this purpose is the shrub *Clerodendron phlomoides,* locally called *husulakki,* which can be readily brought up on the ridges in between the ploughings. The putting up of these hedges across the main wind direction ought to be made binding upon the cultivator, by suitable legislation if necessary.

Tree planting near villages might also be made a regular, annual event. A communal tree planting day in the year could be instituted just at the commencement of the rainy season, on which day the villagers may be encouraged to plant up cuttings or seedlings of useful species like *Ficus, mahua* (*Bassia latifolia*), *jamoon* (*Eugenia jambolana*), *nim* (*Melia azadirachta*), mango and tamarind, with the object of forming, eventually, a village *tope* near each village containing valuable tree species.

NOTES RELATING TO CONTOUR TRENCHING IN THE BAMIABURU AND RORO AREAS

(Issued from the Forest Research Office, Bihar.)

It has been considered advisable, particularly for those readers interested in contour trenching as a means of land improvement or reclamation, to clarify the position of some of the points raised in items (1) to (8) at pages 301 and 302 of the article on contour trenching in the June issue of the *Indian Forester.* They are in seriatim: (1) This refers to three small uniform crops of young sal poles of about 6 acre in extent that were laid out originally in May, 1937, for thinning tests, rather less than a year after the extension of the contour trenching system to this area. The fixing of the quality of the original crops, clear felled some years ago, has been a matter of some difference of opinion among local forest officers as no one can be expected to remember exactly what such a small area contained. It was therefore decided in conference to consider the issue on the basis of Haine's stock-map for the Singbhum Working Plan, of 1901-02. The site of these plots was then surveyed and found to be in the "well stocked sal valley type", and, in his Working Plan, Haines defines this type as "in most of the valleys and on the slopes with favourable aspects and sufficient soil, the sal is capable of exceeding 6 ft. in girth and attaining a height sufficient to yield good timber and crops containing sal trees of this description are termed Valley Type". From the descriptions of 1923 and 1934 in the Compartment History the quality of the crop in and near the site would then have been at least good quality III. In the circumstances data based on such records could hardly be scientifically relied on.

(2) In the trenched areas of Bamiaburu and Roro there are two established experimental plots for testing the influence of contour trenching on sal recruitment. In the former area E.P. No. 23 was laid out in 1934 with three sub-plots and designed as (A) situated 5 ft. below the trench and fed from it by two outlets; (B) situated 6 ft. above the trench; and (C) laid out 37 ft. below the trench and below sub-plot (A). In 1935, a loop trench was cut through sub-plot (B) for reasons the records do not explain. An enumeration of the recruitment was made in 1938 and the follow-

ing comparative results obtained with the initial counts recorded in 1934:

Recruitment Factors	Sub-plot A		Sub-plot B		Sub-plot C	
	1934—1938		1934—1938		1934—1938	
No. stocked squares ..	28	40	36 out of 40	37 out of 41	17	31
Percentage of stocking ..	58	83	75	90	35	64·6
Average height in feet ..	2·4	2·6	2·3	3·4	2·5	2·45
Established height in feet	10	10	10	10	10	10
Estbd. stocking factor ..	13·34	21·6	17·25	30·6	8·75	15·8
Increase percentage ..	61·9		77·3		80·5	

This shows that sub-plot (C), the furthest from the contour trenching system, and in the words of the 'Initiator', "unlikely to be affected by irrigated water", has made the largest proportionate increase.

In the case of the latter area two parallel plots were laid out in 1938 just above the Roro trenching system and a similar trench dug above one of them. An enumeration of the recruitment progress was made in 1941 and the following extract from the Research Annual Report of that year is taken of the comparative results obtained:

Recruitment Factor	Plot No. 1 Trenched above	Plot No. 2 Not trenched above
Established stocking Factor calculated from 1938 ..	·02	·07
Established stocking Factor calculated from 1941 ..	·02	·12

The records of these two plots also show that there was no recruitment of sal in the trenched area during the interval between counts. It will be evident, therefore, that the experimental data available at present on recruitment progress are too scanty and conflicting to be of concrete analytical service. In passing it may be mentioned that an added difficulty of the use of data from these plots will be the sowing of *Boga medeloa* along the trench parapets, etc., which has introduced an independent factor of influence.

(3) It is presumed that the observation is based on casual appearance since there are no records of actual experimental work or counts on sal regeneration and its survival, etc. On this issue it may be noted that records in the Compt. History of Santara 15 show that inspecting officers were generally impressed with the condition and vigour of the sal regeneration in the C.W.C. area prior to the initiation of any contour trenches, *i.e.* in 1923, 1926, 1930 and 1934. A typical remark being that of the D. F. O. in 1930: "*In most places a final felling can be carried out as the regeneration is good 5—10 ft. high*".

4. The Santara block is typical of much of the Singbhum broken and irregular topography with ecologically dry conditions largely prevailing on the middle and higher slopes while there are several damp types with streams (and rivers) carrying perennial water from the middle slopes downwards. In the Pogomara valley, 50 ft. below the lower main masonry bund of trenching system, the vegetation contains such species as:

Tree and Shrubs ...	*Amora Wallichii, Litsea nitida, Pygeum acuminatum, Carallia integerrima, Bichofia javanica, Cedrela toona, Micromelum pubescens, Ardisia solancea, Daedalacanthus nervosus, Bohmeria platyphylla.*
Climbers and Epiphytes ...	*Entada scandens, Vitis auriculata, Scindapsus officinalis, Rhyncostylis retusa.*
Grasses ...	*Oryza latifolia* and *granulata, Amphilophis kuntzena, Themeda villosa, Brachiaria kurzii.*
Ferns ...	*Dryopteris moulmeiense, Dryopteris parasitica, Pteris pellucida.*

Photographs, unless retaken at the same time of the year and without a marked and striking alteration in the condition of the subject, are an unsatisfactory medium of scientific comparison. Twelve photographic points fixed and shot in the Roro trenching area in 1938 were retaken at the same time in 1941 in two places, the other fixed points not then being traceable, and the results showed no apparent alteration in local conditions.

(5) Similar morphological features have been recorded and seen in many parts of Singbhum where there are no contour trenches. Dr. Bagchee, the F. R. I. Mycologist, after visiting the local divisions, thought they might be associated with the prevalance of the fungus *Trametes inserta*.

(6) This probably refers to E. P. Nos. 50—53 laid out near Patung in 1938, comprising two pairs of contiguous plots. In each pair a contour trench was dug along the upper boundary of the plot selected as the treatment site, measurements were recorded of the standing crop, and the entire crop then coppiced and cleared. Measurements of the leading shoots were taken in 1941 and the comparative results published in the Research Annual Report of that year, and from which the following extract is provided:

Measurement Factor	Time of Measurement	Plot No. 51 (Control)	Plot No. 50 (Trenched)	Plot No. 53 (Control)	Plot No. 52 (Trenched)
Average diameter of overwood before coppicing.	1938	6·2 in.	7·1 in.	5·0 in.	6·5 in.
Average height of leading coppice shoot ..	1940	13·3 ft.	14·5 ft.	14·0 ft.	15·7 ft.

The results have shown a slight advantage of height in favour of the trenched plots, but it should be noted that the coppice shoots here had a similar advantage in the size of the stools from which they have sprung.

The above notes are given, not as a criticism of contour trenching as a possible means of reviving lost land productivity, but that there are no actual data so far from which to gauge the influence of such trenching on the growth, ecology and stocking of the forest crops at Bamiaburu and Roro.

[No further articles or correspondence will be published on this subject for some considerable time.—*Ed.*]

ADVANCE THINNING FOR TEAK PLANTATIONS

BY M. A. K. KHLAIL,

U. P. Forest Service.

The article in the *Indian Forester* for August, 1942, on the application of advance thinning to teak plantations forms an interesting reading, in which Mr. A. B. Lal recommends advance thinning as the most advantageous method of tending teak in young age. The addition of a new name to the already long list of thinning methods (which, it seems, has become boring to many foresters) and the association of two famous names with it will, perhaps, dazzle every forester in India. No conclusive and statistically supported experiments have yet been performed to prove the *pros* and *cons* of the problem; but all kinds of conjectures are made about it and hypothetical virtues are ascribed to it. The only attempt to test the method on scientific lines has been done in Nilambur and Wynaad by the Silviculture Division of Madras. Pending their results it will be a grave error to indulge in the drastic thinning involved in this method, specially under conditions prevalent in teak-growing regions of India. From a brief review of the problem its application seems to be of grave disadvantage to teak plantations in India.

The basic idea of advance thinning is *to thin early and thin very very heavily*. Both of the practices are detrimental to Indian teak as I will endeavour to show below.

Experience in the past has proved that teak responds well to thinning even if it is done very late. At many places in the U. P. for example, first thinning has been done in 8—10 years with no apparent detrimental effect on the crop. Therefore, the possibility of the change of "sun-leaves" of teak into "shade leaves", by delayed thinning, leading to lack of response to opening the canopy is ruled out. There is no such danger for teak.

Heavy opening of the crop is sure to produce branches at early age, which will persist and will make a greater part of the tree branchy. It must not be forgotten that Craib and O'Connor have applied advance thinning to *wattle* plantations of South Africa,

which are raised entirely for their bark, to produce tannin. In this case branching is not only immaterial but is a definite advantage by way of increasing the yield. A planter growing trees for fuel, bark, fruits or flowers always tries to make trees as branchy as he can. Teak is grown entirely for timber (for constructional purposes, railway carriages, gun-carriages and furniture). A branchy teak tree will, therefore, yield very small quantity of useful timber. Moreover, the knots produced by branches will ruin the timber both as regards strength and beauty (the two qualities for which teak is so highly valued).

The idea of pruning extensive teak plantations of India and Burma, and still keep them a paying concern seems a little incompatible. The practice of pruning mulberry in the Punjab plantations may be a paying proposition on account of the small areas involved, high price of the timber and short rotation, which does not necessitate long-time investment of capital. The biggest mulberry plantation of the Punjab is in the Changa Manga Division, which does not exceed an ordinary-sized range in any other division. Work, is, therefore, all concentrated in a small area and can be organized and supervised with great ease and at low cost. Compare with this small area, the vast plantations of teak in Bengal, Assam, Burma, Madras, C. P. and Bombay. It cannot be a profitable proposition to prune these vast plantation areas and smear every single wound with coal-tar. Moreover, mulberry comes up naturally under *sissu* in all so-called mulberry plantations of the Punjab. No expenditure is therefore incurred in soil-preparation and sowing, etc., of mulberry. Hence, any expenditure incurred in pruning mulberry is admissible.

Reference to timber price lists shows that teak sells for Rs. 1-8 to Rs. 4 per c. ft. on an average, and mulberry for Rs. 1-2 to Rs. 2-8 per c. ft. From this it would appear that teak fetches a higher price than mulberry and it may be argued by some that a higher expenditure on teak plantations is financially justified. A little consideration will show that this is a financial paradox. Consider these prices with the fact that the expenditure on raising teak plantation is already high, being on an average about Rs. 100 per acre at a very modest estimate. On the other hand, the expenditure

on the actual growing of mulberry in the Punjab can be regarded as negligible. Also, the capital invested in a teak plantation remains locked up for 90—100 years, while that invested in a mulberry plantation is realized after 18—20 years. From this it is evident that the lower price of Rs. 1-2 to Rs. 2-8 per c.ft. obtained for mulberry is ultimately more paying than the comparatively higher price of Rs. 1-8 to Rs. 4 per c. ft. obtained for teak. All forest operations should be considered from purely economic point of view and before any large-scale work is started a reasonable return on tax-payer's money invested must be assured. It is thus evident that the practice of pruning of mulberry in the Punjab does not justify its application to the teak-growing regions.

Consider also the fact that all the teak-growing places in India and elsewhere have got an annual rainfall ranging from 50 inches to 200 inches and some have even more. This high rainfall combined with the high temperature of the teak zones provide ideal conditions for the growth of weeds, shrubs and climbers. They may be kept suppressed as long as the canopy is closed but the moment a heavy opening is made, as is envisaged in advance thinning, they will spread like wild fire and swamp out everything. Their control and suppression will be unsound finance, and in quite a large number of cases, a physical impossibility.

The major part of the crop in a plantation will be removed in the first and second thinnings in the first four years or so if advance thinning is adopted. This crop will be hardly 4—6 inches in diameter in good teak zones and smaller still in poor ones. This material will either be entirely unsaleable, or, at the best, may fetch a price which in most cases will be incompatible with the cost of thinning operations. The advance thinning will thus be a pure waste and will amount to squandering away at least 75 per cent. of the invested capital.

All the teak-growing regions of South India are subject to very fierce cyclonic storms. Teak is very shallow-rooted, and on this account, a very wind-tender species. Heavy opening of the crop by advance thinning will, in this case lead to the exposure of tender, shallow-rooted saplings and poles to heavy storms which may at

times be so furious as to result in wholesale destruction of a teak plantation.

Another difficulty is that vast areas in South India become converted into lateritic rock on exposure. Heavy thinning and drastic opening of the canopy thereby, produces this exposure of the site which is sure to result in the conversion of good productive soil into hard, unproductive laterite.

Mr. Lal is afraid that timber will get into disrepute in time to come on account of increasing popularity of steel and concrete as building materials. Steel and concrete have come into fashion since about 50 years or so, or maybe even a little more. In spite of all the propaganda by steel magnates and cement cess boards and almost negligible propaganda by the forest departments and forest owners in India, demand for timber is increasing every day. Value of timber as constructional material in all the hills of India, and in all places where rainfall is anything above an annual average of 70 inches, is still unchallenged by other materials. In addition to building work, timber is required for thousands of other uses, whose variety and extent are ever expanding. Increasing demand for timber is proved beyond doubt by the yearly outturn figures of the different provinces and states of India. These figures show that there is no chance whatever of a decrease in demand for timber at any time to come. In fact, all foresters in India, who follow their profession with any sense of professional honesty and duty to the nation, worry much as to how to meet the ever-increasing demand for timber in the country. It is a well-known fact that about 50 years back the only timbers used in India were teak, *sal,* deodar, *chir* and *shisham.* The country's resources in these timbers were soon found to be exhausting and inadequate to meet the increasing demand. Schemes were, therefore, set afoot to regulate and expand these forests as quickly as possible, and in the meantime to find out other timbers which could be used as substitutes, so that the strain on the limited reserves of these timbers might be reduced. There is, therefore, no need to be afraid of a collapse of timber trade and insolvency of forest concerns; nor is there any need to take out all the invested capital at ridiculously low rates in the form of small-sized timber to be cut out in advance thinning. This will be

as short-sighted a policy as that of a rich merchant in India, who being afraid of a turmoil consequent on the opening of hostilities with Japan sells away all his business at extremely low price and squanders the stock-in-trade, but at last repents for his folly, when he finds after a few months that his apprehension was not true.

Thus both from Silvicultural and financial considerations it is evident that the plea of *early heavy thinning for teak* is hardly sound. The good old motto of Silviculture *"thin early, but thin light and thin frequently"* is still the golden principle to be followed for thinning teak plantations in India.

A RARE INVESTITURE CEREMONY

The Convocation Hall of the Forest Research Institute, Dehra Dun, was the scene of a very happy occasion on the 23rd of December, 1942, when the initiative, brave courage and tact of Mr. Edmund Joseph, the present Experimental Forest Ranger of the Forest Research Institute, were given recognition and the British Empire Medal was presented to him by Mr. S. H. Howard, Inspector-General of Forests to the Government of India, on behalf of His Majesty the King-Emperor.

The Inspector-General addressed the gathering in the following words:

"LADIES AND GENTLEMEN,

Before I begin I must apologise that I was unable to provide more sitting accommodation. As you know, this hall with other parts of the Institute has been handed over for the duration of the war for the care of the wounded. Consequently, we have had to put in these few chairs at a moment's notice. However, I am perfectly sure, considering the occasion, that none of you will mind this small inconvenience.

We are gathered here to present Mr. E. Joseph, a Forest Ranger of the Andamans, with the British Empire Medal, the award of which was specially approved by His Majesty the King in June 1942, and appeared in a special notification of June 6th.

Those of you who have gone down to the sea in ships know well, how lonely it can be when surrounded by water as far as the eye can stretch out of sight and sign of land. You can well imagine how far more lonely it could be seen, not from the decks of a luxurious 20,000-ton liner, but from a small ship like the *Norah,* 42 feet long. It requires a good deal of courage to go to sea in such a ship at all, but to do so on your responsibility in command of a tiny fleet of three ships with a voyage of many days ahead of you, is sufficient to make the bravest man think twice, especially if he had no knowledge of navigation. That is what Mr. Joseph did. He had no knowledge of navigation and had to rely on what survey he had learnt as a student of the Rangers Forest College here in Dehra Dun.

Towards the end of February 1942, it became clear in the Andamans Islands that the forest craft might be subject to attacks both by Japanese surface raiders and from the air. It was therefore decided to remove the larger craft by evacuating them to Vizagapatam a distance of more than 700 miles across the ocean.

It was agreed that this little fleet of ours should be convoyed by a vessel of the Royal Indian Navy but this struck a mine and was lost—a happening which did little to encourage our crews. When Mr. Foster suggested that the little fleet should sail under the command of Mr. Joseph, the crews trust in his general capability was such that they all readily agreed to sail under him. He took command of the fleet at a little over 18 hours' notice during which I presume he did his best to learn something about navigation.

There were no up-to-date nautical tables and the only advice that could be given to him for navigation was that he should take sights with a sextant on the pole star and thereby get into the latitude of Vizagapatam, about 18 degrees north, and then sail along that latitude until he hit India. He was therefore navigating with no better method than that of Christopher Colombus when he discovered America and his greatest progress was not very much faster because the speed of the fleet was not more than 4½ knots.

He actually made a landing after 7 days only about 40 miles from Vizagapatam and as the altitude of the pole star varies sufficiently to give this error it was a very efficient feet of navigation.

To take this responsibility, especially at the time he did it and to sail his little fleet safely home with so little knowledge required considerable courage. The Andamans were being subjected to air-raids and reconnaissance planes were coming over daily. Had the vessels been spotted the only possible result would have been their sinking with the death of all on board. Added to this there was a strong probability of being attacked by a surface raider.

But Mr. Joseph's coolness and courage brought his little fleet safely to port. As a result of his action the *Surmai* and the *Montague Douglas*, each of 370 tons, and the little motor-launch *Norah* were all saved. The value of these craft is probably about seven lakhs of rupees, but they are irreplaceable to-day. The *Surmai* is now an armed patrol vessel, the *Douglas* is a fleet tender and the *Norah* is an examination launch. All three therefore are actively helping in the defence of India.

I am exceedingly proud that one of our men has got this medal. It is an example to all of us but you students of the Rangers College have perhaps the greatest right to feel proud as he is one of you, he adds to your traditions and his example is something for you all to try and follow.

I have much pleasure in being permitted to present this medal."

After the above speech the Inspector-General, amidst deafening cheers, decorated Mr. Joseph who was sitting on the dais by his side, with the Medal and the short proceedings of the memorable gathering came to a close.

We extend our hearty congratulations to Mr. Joseph once again. Our congratulations also go out to the Director and the Tutorial Staff of the Forest Rangers College, Dehra Dun, for having turned out persons like Mr. E. Joseph. It throws a flood of light on how soundly the College trains its students who in their after-life so courageously fulfil jobs which would make even the professionals shudder.

TIMBER PRICE LIST, NOVEMBER-DECEMBER, 1942

(INDIAN STATES)

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE)

Trade or common name.	Species.	Locality.	Description of timber.	Prices
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Cochin ..	Logs ..	Re. 0-8-0 to 0-11-0 per c.ft.
,,	,,	Travancore ..	Logs ..	Re. 0-12-0 per c.ft.
Benteak ..	*Lagerstrœmia lanceolata*	Cochin ..	Logs ..	Re. 1-0-4 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	
,,	,,	Travancore ..	Logs ..	Rs. 2-3-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Barwani ..	Logs ..	Re. 0-12-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	
,, ..	,, ..	Dhar ..	Logs ..	Rs. 1-8-0 per c.ft.
,, ..	,, ..	Holkar ..	Beams 14′ × 18″	Rs. 2-0-0 to per c.ft.
,, ..	,, ..	Hyderabad ..	Logs ..	
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Patna ..	Logs ..	
,, ..	,, ..	Travancore ..	Logs ..	Rs. 2-7-0 per c.ft.
Deodar ..	*Cedrus deodara* ..	Patiala ..	Sleepers 10′×10″×5″	
Dhupa ..	*Vateria indica* ..	Cochin ..	Logs ..	
Gamari ..	*Gmelina arborea* ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-12-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Cochin ..	Logs ..	Rs. 1-9-11 per c.ft.
,, ..	,, ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-12-0 per c.ft.
Haldu ..	*Adina cordifolia* ..	Bansda ..	Logs ..	
,, ..	,, ..	Banswara ..	Logs ..	
,, ..	,, ..	Barwani ..	Logs ..	Re. 0-8-0 per c.ft.
,, ..	,, ..	Bhopal ..	Logs ..	
,, ..	,, ..	Cochin ..	Logs ..	
,, ..	,, ..	Dhar ..	Logs ..	
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Patna ..	Logs ..	
,, ..	,, ..	Travancore ..	Logs ..	Rs. 2-0-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Cochin ..	Logs ..	Rs. 1-6-2 per c.ft.
,, ..	,, ..	Travancore ..	Logs ..	Rs. 3-1-0 per c.ft.
Indian Rosewood ..	*Dalbergia latifolia* ..	Bansda ..	Logs ..	
,, ..	,, ..	Barwani ..	Logs ..	Re. 1-0-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	Rs. 2-2-3 to 3-9-3 per c.ft.
,, ..	,, ..	Dhar ..	Logs ..	Rs. 1-8-0 per c.ft.
,, ..	,, ..	Kishengarh	Logs ..	
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Patna ..	Logs ..	
,, ..	,, ..	Travancore ..	Logs ..	Rs. 1-15-0 to 2-4-0 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Irul ..	*Xylia xylocarpa* ..	Cochin ..	Logs ..	Re. 1-0-3 to 1-10-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Rs. 1-13-0 per c.ft.
Kindal ..	*Terminalia paniculata* ..	Cochin ..	Logs ..	Rs. 1-6-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Rs. 2-14-0 per c.ft.
Laurel ..	*Terminalia tomentosa* ..	Bansda ..	Logs & squares	
" ..	" ..	Barwani ..	Logs ..	Re. 0-10-0 per c.ft.
" ..	" ..	Bhopal ..	Logs ..	Re. 1-8-0 to 2-8-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Holkar ..	Sawn material	
" ..	" ..	Hyderabad ..	Logs ..	
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Patna ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Rs. 2-11-0 per c.ft.
Mesua ..	*Mesua ferrea* ..	Cochin ..	..	
" ..	" ..	Tripura ..	Logs ..	
Sal ..	*Shorea robusta* ..	Cooch Behar	Logs & scantlings	
" ..	" ..	Patna ..	Logs ..	
" ..	" ..	Tripura ..	Logs ..	Re. 1-8-0 to 2-8-0 per c.ft.
Sandan ..	*Ougeinia dalbergioides* ..	Bansda ..	Logs ..	
" ..	" ..	Patna ..	Logs ..	
Semul ..	*Bombax malabaricum* ..	Banswara ..	..	
" ..	" ..	Cochin ..	Logs ..	Re. 0-8-0 to 0-11-0 per c.ft.
" ..	" ..	Cooch Behar	Logs & scantlings	
"	" ..	Rampur ..	Planks 6′ × 1′ × 1¼″ ..	
" ..	" ..	Travancore ..	Logs ..	Re. 0-12-0 per c.ft.
" ..	" ..	Tripura ..	Logs ..	Re. 0-6-0 to 0-12-0 per c.ft.
Sissoo ..	*Dalbergia sissoo* ..	Banswara ..	..	
" ..	" ..	Cooch Behar	Logs & scantlings	
" ..	" ..	Hyderabad ..	Logs ..	
" ..	" ..	Rampur ..	Planks 6′ × 1′ × 1¼″ ..	
Teak ..	*Tectona grandis* ..	Bansda ..	Logs ..	
" ..	" ..	Banswara ..	Logs ..	
" ..	" ..	Barwani ..	Logs ..	Re. 0-12-0 to 1-8-0 per c.ft.
" ..	" ..	Bhopal ..	Logs ..	Rs. 3-8-0 to 4-8-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	Rs. 1-13-0 to 5-9-0 per c.ft.
" ..	" ..	Holkar ..	Sawn material	Rs. 4-0-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Rs. 2-[illegible]-0 to 5-8-0 per c.ft.

EXTRACTS

THE MILKY WAY

The barrels of most of our fountain-pens and eversharp pencils are made from milk plastics. The gloss of fine writing paper is entirely dependent upon milk for its finish. Milk is used in the preparation of plywood for airplanes to help men fly, and in chemical sprays to keep insects from flying. The Bureau of Standards gives casein glue a very high rating for use in such vital places as airplane construction, rafters of barns, etc.

It is reported that one of the ambassadors to England wore one of the 'milk suits' made from 85 quarts of chemically treated skim milk. And 'the skin you love to touch' is that way in part because of milk-base beauty cream, plus some fortification from dairy products she has consumed.

We don't know where the 'white magic' of milk will lead to, but Prof. G. H. Rolfins of Verginia Polytechnic Institute says:

Soon you may be crawling out from between blankets made of milk spread on a bed which milk holds together, in a milk-painted room. A rug of milk can protect your feet from the cold floor. You may turn on a faucet handle of milk to produce your morning shower, after which you may shave with a milk handle razor. You may comb your hair with a comb of milk, and brush it with a milk-baked brush, and perhaps admire the result in a milk-backed mirror.

You may don your suit of warm milk wool, held in place by buttons of milk and matched to the "T" with your milk-plaid neck-tie. Probably you will wish to turn the milk knob on your radio and press the milk button for the station you like to listen to. Your cream-drenched cereal may be served in a bowl of milk, and eaten with a milk spoon. After you have finished eating you can open the milk wrapper of a cigarette package for your smoke. Before leaving for the office you should kiss your wife on the forehead, made soft by milk base beauty culture. Last, but not least, do not forget to take out your milk barrelled fountain pen and write a cheque on another sheet of milk surfaced paper to pay the bills," (*The milk bill.*)

P.S.—Wonder whether we might not make a cow stable of milk, milking-machine of milk and, possibly, some milk milk-bottles. Whoa! Before we get involved in a tangle like the 'Which came first, the hen or the egg' controversy we'd better just stop here and close this article on 'white magic' with a toast to the producer of what started out as just the most nearly perfect food for mankind which it still is, of course. So, here's to the cow! The Foster Mother of the World! (Adapted from *The Goat World.*)—*Indian Farming*, dated July, 1942.

THE NEED FOR BETTER WOOD UTILIZATION

C. W. STRAUSS,

U. S. Forest Service

The importance of improving our methods of harvesting, converting and using forest products has been emphasized so often that little can be added to the basic truths covering situations and needs. It is generally agreed that nearly two-thirds of the total forest drain is wasted in the woods, in manufacture, and in unwise use. Although the past two or three decades have brought improvement in woods, mill and service practices, the surface of the problem has been no more than scratched.

This subject is of surpassing importance to the South which has the responsibility of supplying the nation with all of its naval stores products, over a third of its domestic lumber and wood pulp, nearly a quarter of its wood boxes and planning mill products, substantial amounts of cooperage, wood furniture, caskets, and many other items.

To illustrate only a few points concerning our need for improved southern wood utilization practices, our small circular sawmills probably miscut lumber in the volume of 300 million board feet a year, representing an industrial waste of some 6 to 10 million dollars; damage by termites in the South amounts to perhaps $10,000,000 annually and wood replacements necessary because of decay probably have a value of some $20,000,000. Examples of similar losses in wasted misused, and unused wood material could be extended almost indefinitely. These losses in money and material effect, in one way or another, every citizen of the South in increased costs, decreased income, and unnecessarily reduced forest resources.

The basic problem involved is as obvious as is the situation. Wood and woods waste in lumber occur, for example, in somewhat the following percentages:

	Per cent. of lumber drain on forest
Woods losses—stumps, tops, breakage	24
Decay—in storage and service ...	20
Mill waste	12
Seasoning	4
Remanufacture	2
Others	4
Total waste	66

In other primary industries the above waste classification would probably approximately apply. We should, of course, concentrate our efforts on the major items of reducible waste, that is, waste in the woods and at the mill, and wood losses due to decay. These points of attack have, however, been recognized for years and many agencies, notably the Forest products Laboratory, have directed their efforts toward improvement and correction.

The logical approach toward the solution of the wood utilization problem has been the three-step method of: 1. Analysis; 2. Research or investigation; 3. Extension. Due mostly to lack of adequate funds, a great deal more time and money has been spent on research and analysis than on extension of information thus obtained. This is logical in a degree, but is obviously a short-sighted policy if carried to a point where a great fund of practical information is given only limited application because it is not placed in the hands of those who can best use it. That is, even though admitting a considerable advance in better practices, we still have a great gap between accomplishment and objective, especially in the extension of research results to practical and commercial application.

It appears, then, that the fundamental problem of improving wood untilization practices is one of extending the practical results of research to everyday use by the forest products and other industries, and by the consuming public. In final analysis it means the improved education in wood use of our entire adult and school-age population with special emphasis on certain industrial and using groups.

Further consideration of the general relationship between forest products research and the application of research results is necessary before we can intelligently consider the matter of solutions. In general, those working on products research find that:

1. Recommended improvements in utilization resulting from research in the highly technical fields of chemistry and physics are adopted most readily by the industries. This applies to the manufacture of pulp and paper and plastics, to the preservative treatment of wood, and to the other so-called "high investment industries. Information is transmitted readily through trade associations and the trade press, and promptly applied by highly trained and specialized personnel.

2. Improved utilization practices generally are adopted readily by the larger and more aggressive lumber manufacturers and furniture plants and by those units of the forest products industries which are well financed and efficiently operated. Here again, trade association membership and trade literature offer a direct channel from research results to commercial application.

3. Below these groups lies an enormous hodgepodge of wood manufacturers, fabricators, converters and users. Some few of these apply the results of wood utilization research to their personal advantage and to that of the public, but most of them are not reached by extension efforts to any considerable degree. This unclassifiable group probably manufactures or processes about 50 per cent. of the industrial forest products requirements and consumes an even larger percentage. Typical are the operators of most small circular sawmills, the owners of small furniture and wood-working factories, most home-building contractors, farmers and the general public.

It may be said that the major need in the effort to bring about better wood utilization is to carry the essential facts of wood conversion and use to this so-called hodgepodge group. This may appear to be both a logical conclusion and an impossible task. The impossibility is granted regarding immediate and widespread improvement but not with respect to extension results which would be much more effective than those currently employed.

To obtain these more effective results most foresters, and specially those in public service, need to expand their fields of effort and knowledge to include a proportionate place for forest products utilization. They need to recognize that more efficient wood conversion and use are equivalent to increased wood growth in the forest and, as such, deserve to be included more fully in their public relations activities, work plans and extension efforts.

The following summarizes some of the methods by which most foresters can more fully meet their obligation to help in bringing about better forest utilization. For convenience these methods are classified under our sub-divisions of forest products problem analysis, research and extension.

Problem Analysis.—The public institutions working on wood research, like all public agencies, justify their existence only through the value of their work to the public. Their best service is given only if they correlate closely forests products research activities with the priority of forest products problems. This is recognized by the Forest Products Laboratory and others, and a commensurate amount of time is spent in problem analysis and in determining need priority.

In spite of problem and priority recognition, no group of specialised workers, can hope to cover entirely a field as wide as that of forest products research unless added by considerable outside interest and assistance. All foresters, therefore, can contribute to the cause of better wood utilization by suggesting research needs to the several agencies competent to do the necessary research or investigation. As an example of a problem which may or may not have been called to the attention of the research agencies, there is now in use in the South a portable, sheet-metal charcoal kiln apparently well-adapted to the conversion of low-quality hardwoods from farm woodlands and other forest holdings into a high-quality and readily saleable product. There are a number of problems regarding the operation of this kiln which, as yet, have limited its general use and which, to a considerable extent might be solved by a combination of research and investigation.

Foresters employed by the industries should specially pass on to the research agencies those problems with which research is best equipped to deal.

Research.—This field is one in which the forester who is not specialised in some phase of wood utilization can make comparatively limited contributions. In total, however, these contributions can lead to substantial results. With restricted facilities for collecting data, all research organizations welcome supplementary facts bearing on their research activities. Service data on proprietary wood preservatives, service and experience with fence-posts treated by the zinc chloride tyre-tube method, unusual reactions of wood in service, and new uses for wood are a few of the many items which could be contributed to the cause of better wood utilization by the average forester.

Extension.—The extension or salesmanship of good wood utilization practices, as the weakest link in the solution of the utilization problem, is also the field in which we can offer the most effective contribution. Many of the basic practices of efficient utilization require no specialised training other than that which all foresters have had, and which in most cases have been permitted to lie dormant.

Farm Extension.—Those few foresters who are directly engaged in extension work have the opportunity and obligation of bringing some of the elements of proper wood use to the farmers and other groups with whom they are working. Simple facts, such as the relative fuel values of local species, comparative durabilities, fence-post treatments, painting practices, and protection from insect damage, are readily understood by the co-operating extension workers and by farm operators. No recommendation is made that the importance of forest protection, management, planting, and marketing be emphasized less, but only that good practices of wood use are also important in successful farm operation and maintenance. The results of greater activity in this direction over a period of years, with the help of other extension workers, could be enormous.

Industrial Extension.—Along another extension front, forestry schools and other agencies in the South have acquired, and are acquiring, the specialised personnel and equipment needed to initiate training and demonstration programs directly with the forest products industries. Extension in the fields of circular saw-mill technique, dry kiln operation, and along other lines of utilization could now be initiated in several parts of the South with good results. An inventory of specialised personnel and demonstration equipment is needed, as well as a general plan of industrial extension.

Trade Extension.—Closely correlated with direct industrial extension is the practical need for the education of trade representatives and related personnel in the subjects of wood properties and uses. Lumber salesman, architects, builders, and others would welcome the opportunity of increasing their knowledge of the commodity with which they work and, here again, only little effort has been made to supply a current and important need.

Personal Extension.—It is reluctantly admitted that both private and public foresters, know too little about the every-day consumer problems of wood use. They, and their friends, build homes, put up fences, make lawn furniture, and dabble with simple or complex woodworking. Too few foresters are able to contribute suggestions which, in the aggregate, would result in many consumer dollars being saved and wood service greatly improved. Moisture content specifications, decay preventives, protection from insect damage, the elements of lumber grading, specialised species properties, wood finishes and reactions are normally outside their scope of knowledge.

The sum of these thoughts on this important subject can be given in three simple statements:

1. The need for better wood utilization is to-day little less acute than it was 10, 20 or 30 years ago.

2. The information necessary to accomplish better utilization is available but many industrial units and most wood consumers fail to realize the importance of efficient wood use and also fail to take advantage of the facts made available to them at public expense.

3. In the absence of funds needed to consistently bring the results of forest products research to those industries in which these should be applied, and to the general public, *all* foresters should recognize more fully that wood waste is forest waste, and that they are obligated, therefore, to assume a larger share in forest products extension.—*Journal of Forestry,* Vol. 40 No. 2, dated February, 1942.

INDIAN FORESTER

FEBRUARY, 1943

THE BOARD OF FORESTRY MEETING, 1942

The Board of Forestry which met at Dehra Dun from 31st October to 3rd November, 1942, was the first to meet since 1934. It marked a new departure from the Boards of Forestry of the past in that for the first time the Ministers from certain provinces attended. The Board was presided over by the Hon'ble Member of the Department of Education, Health and Lands, Government of India.

The following were present:

The Hon'ble Sardar Sir Jogendra Singh, Kt., Member-in-Charge of the Department of Education, Health and Lands, Government of India. (*Chairman.*)

The Hon'ble Mr. Upendranath Barman, Minister-in-Charge of Forests and Excise, Bengal.

The Hon'ble Pir Illahi Bakhsh Nawaz Ali, Minister-in-Charge of Forests, Sind.

Mr. S. H. Y. Oulsnam, C.I.E., M.C., I.C.S., Secretary to the Government of India, Department of Education, Health and Lands.

Mr. S. H. Howard, I.F.S., Inspector-General of Forests to the Government of India and President, Forest Research Institute and Colleges.

Sir Harold Glover, Kt., I.F.S., Chief Conservator of Forests, Punjab.

Mr. C. M. Harlow, C.I.E., I.F.S., Chief Conservator of Forests, Central Provinces and Berar.

Mr. D. B. Sothers, I.F.S., Chief Conservator of Forests, Bombay.

Mr. W. G. Dyson, M.C., I.F.S., Chief Conservator of Forests, Madras.

Mr. W. T. Hall, C.I.E., I.F.S., Chief Conservator of Forests, United Provinces.

Mr. C. E. Simmons, I.F.S., Conservator of Forests, Assam.

Mr. J. W. Nicholson, C.I.E., I.F.S., Conservator of Forests, Orissa.

Mr. T. M. Coffey, I.F.S., Conservator of Forests, Bengal.

Mr. D. Davis, I.F.S., Conservator of Forests, United Provinces.

Mr. G. R. Henniker-Gotley, D.S.O., I.F.S., Conservator of Forests, North-West Frontier Province.

Mr. J. Petty, I.F.S., Conservator of Forests, Sind.

Mr. L. R. Sabharwal, I.F.S., Conservator of Forests, Bihar.

Mr. M. S. Rangaswami, M.F.S., Chief Forest Officer, Coorg.

Mr. J. D. Atkinson, I.F.S., Conservator of Forests, Burma.

Mr. F. T. Morehead, I.F.S., Conservator of Forests, Burma.

Mr. S. H. Howard welcomed the Hon'ble Member and the members of the Board on behalf of the Forest Research Institute in a short preliminary speech.

Then the Hon'ble Member Sardar Sir Jogendra Singh, Chairman of the Board, delivered his opening speech to the Board. He stressed the importance of proper forest management and prevention of floods and erosion. "Trees possibly are the firstborn of mother earth; where there are trees, there is rain. Where trees die, the earth ceases to bear altogether. The forests have played and will continue to play a very vital part in the life of humanity."

Below is the full text of the Hon'ble Member's address:

"It is years since I enjoyed the hospitality of Sir George Hart, the then Inspector-General of Forests, when I came to Dehra Dun to assist in selecting candidates for the Imperial Forest Service. The Colleges and the Forest Research Institute were still in the making. It was the ambition of one of my predecessors—the late Sir Narasimha Sarma—to raise the Forest College up to the highest European standard. I rejoiced when on the 1st November, 1926, the College opened its doors to receive candidates, and I deeply regretted when after a very short period of six years its doors were closed on the 1st November, 1932.

I am glad to know that provinces have been driven to recognize the need of highly trained officers and the College has been opened again. I am pleased to know that the standard prescribed for the Indian Forest College is the same as the degree course of a British University leading up to the grant of the College diploma in Forestry. It will be for you to consider whether any further improvement is necessary in the course at the Indian Forest College or the Indian Forest Rangers' College.

I am gratified to know that the Research Institute has suffered no eclipse. It has proved its value in these difficult days of war. Research finds recognition when it begins to cater for the public needs and helps in meeting our urgent requirements in creating new industries.

I am glad that the Research Institute under the fostering care of Mr. Howard has substantial achievements to its credit. Its Botany, Silviculture, Entomology, Chemistry and Forests Products Branches

have been making material contribution to meet the demand of the army. The Institute has been instructing officers in the art of identifying various varieties of timber, exploring other sources of vegetable rubber, producing oils from chir pine and developing processes which have enabled a firm to produce disinfectants for our troops. The Institute has produced ephedrine from ephedra, and derris and tar from pines. It has determined the kind of charcoal best suited for generating producer gas.

The Timber Testing Section has tested ammunition boxes, army boot boxes, crates for sola topis, propellers, spars for plywood, glue joints, parachute containers and a number of other special articles completing nearly half a million tests. It has discovered a new form of construction using hard wood dowels for roof trusses and bridges, saving a considerable amount of metal and money. In one case the application of this discovery saved six-lakhs of rupees. The way to defeat armies of white ants has been found and adopted by the Supply Department and seasoning in kilns has proved its value and gained in popularity. There are 68 kilns now at work.

The Wood Working and Mechanical Section is generally a supply unit but it has broadened its scope of activities and made plywood containers, laminated boot lasts, naval plywood, and test ammunition boxes. A cold-setting adhesive and new glues from indigenous products has been evolved to replace casein and other types of cements needed for naval and other uses.

The Institute has proved that India has suitable timber for use in aircraft, which was considered out of the question a year ago. There are now three officers on special duty exploiting spruce and fir for this purpose. A large variety of plywood containers have been constructed at the Institute as substitutes for metal containers, ranging from one-pound tins and containers to sturdy 50-gallon drums for road tar. They have been accepted by the army and are now being produced by several firms for keeping oils, greases, dry goods and medical stores. Apart from making and repairing wooden airscrews, the Institute has worked out the technique for making "compregnated" wood (wood which is both compressed and impregnated).

The Paper Pulp Section is engaged in making a bulk supply of paper for various military uses and map paper for the Survey of

India, in addition to investigations connected with natural and synthetic dyes, water-proof paper and specifications for containers for Ordnance and Medical Stores. The scope of development of this branch is as great as the growing demand for paper.

May I now turn from the achievement of the Institute to the formation of the Board which it is my privilege and pleasure to open to-day. It was a happy idea conceived in 1934 that the Ministers in charge of forests and forest officers and experts should meet together every three years and formulate permanent policies. The first meeting of the newly constituted Board was called to meet early in 1939, but provincial Ministers resigned and the meeting was postponed. It is unfortunate that popular provincial governments have not re-started to function.

Eight years have sped their way. New problems have arisen. The need of taking counsel on the general policy for research and education and forest administration during the war and to plan for the future is the reason for our meeting here to-day. Indeed, I feel that though the Board could meet every three years, it would be an advantage if senior forest officers could meet every year and discuss from their own technical point of view questions of general interest and immediate importance at a Forest Officers' Annual Conference in the same way as the Central Board of Irrigation.

I dare not presume to dwell on the numerous matters in the agenda which relate to technical matters. On the broader aspects of forestry, there are one or two points on which a layman can venture to hazard suggestions.

Trees possibly are the firstborn of mother earth; where there are trees, there is rain. When trees die, the earth ceases to bear altogether. It has been established beyond all shadow of doubt that correct forest management in the mountains and hills which form the headwater of our streams, accompanied by proper land management of the area through which these streams pass, are essential to prevent floods and erosion. Neglect leads to denudation, floods and devastation of the countryside. The forests have played, and will continue to play, a very vital part in the life of humanity. They supply fuel to feed the home fires, timber to build implements of

agriculture and dwelling houses, bullock carts and boats to carry the produce and umbriferous trees to provide shade for man and beast.

It was recognition of the importance of preserving forests that led the Government of India in 1894 to define its forest policy which was declared to be on the one hand the protection of the forests and on the other the maintenance of the rights of the inhabitants, unless in the larger interests of the community restriction became inevitable. The terrible ravines of the Chambal and of the Jumna which have devastated the face of a once fair land were not caused by mismanagement by the local inhabitants but by the denudation of forests in the Himalayas hundreds of miles away.

In addition to the growing of actual forests the remedies against floods and erosion are the growing of shelter-belts of trees or growing of leguminous crops which help to enrich the soil, and where erosion has gone too far coarse grasses or sedges can be grown as a preliminary to the introduction of more valuable crops. The spread of ravines can be prevented by proper management. By controlling grazing, ravines clothe themselves with grass and indigenous shrubs. Such measures call for co-operation of the villages and such co-operation has been largely achieved in some parts of the Punjab. The only reason why vegetation has disappeared in most parts of India is because man has indiscriminately hacked and burnt the trees, and has grazed his animals without control and without realizing that the land can only support a definite amount of grazing. It should never be forgotten that to attempt afforestation as a remedy for soil erosion without at the same time controlling man and his animals is a waste of time and money.

The question of proper land management to prevent the devastation, which has spread over so many other countries after deforestation, from laying waste our own fair country has been the subject of debate in various committees connected with the Imperial Council of Agricultural Research, and at last it has been agreed by the Advisory Board of the Imperial Council of Agricultural Research that an officer should be appointed to collect information and to crystallize the problem.

Naturally, the forests have engaged most of the attention of our forest officers. The time has, however, come when they should include the villages as one of their responsibilities. The need of

700,000 villages in the matter of tree plantation has so far received scant attention. It may be useful to take a group of villages to start plantations. Land could be rented for the purpose and trees planted to provide fuel and timber and the grass for feeding the cattle. These village plantations may prove of great economic value, saving the cowdung for manure, and may even provide large quantities of material for making humus and manure.

Another direction to which I may invite your attention is that there are vast areas which climatic conditions make it impossible to bring under cultivation. It may be possible to lift water for irrigation for starting plantations and to grow trees which require a minimum amount of water. An experiment in this direction may enable the afforestation of areas which now lie waste, are classed as culturable but cannot be cultivated.

Increased production from land depends on providing plant food by supplying the soil with manure. Adequate supply of manure is, perhaps, the most important single problem connected with Indian agriculture. The magnificent agricultural crops produced from virgin forest soil are the result of exuberant fertility given by years of leaf shedding and slow decay into humus, providing a first-class vegetable compost. It may well be a problem worthy of the attention of foresters and agriculturists, whether surplus supply of leaf mould fertilisers could not by some method be transferred from the forests to the villages, without drawing on the requirements of the forest soil.

Those villagers who are fortunate enough to live near forests get from them timber for their ploughs, grass for their houses and grazing for their cattle and a host of other material. In addition to that the fertility of their fields is largely increased and their water supply controlled by the protective influence of the neighbouring forests. But what of other unfortunate villagers whc have no forests in their immediate neighbourhood? What of the vast numbers who inhabit the enormous areas of the Punjab and the Gangetic plain? They get none of these amenities, their cattle are often starved, their houses are poor, they are forced to use valuable manure for their fuel, their crops suffer in consequence and the lack of nourishment eventually affects the physique and health of man himself. It is one

of our great problems not only to instil into the mind of the peasant the value of forests to him but if possible to bring the benefits enjoyed by those who inhabit the fringe of the hills near the forests down to the dwellers in the plains. Such work means spending money in initial stages to encourage the villager by actual demonstration how to grow forest for himself on all waste lands. In Madras, in Orissa and in the U.P. work is being done in this direction. Before the war put a partial end to these activities the Forest Development Officer in the U.P. had got a certain amount of work started in many districts of the plains in the U.P. and more especially in those hot and dry areas in the east of the province. There is room for vast improvement in this organization, which I trust, will continue to expand even more rapidly than before.

In earlier days the primary duty of public servants was the administration of law and order; out of it grew a sense of superior aloofness which affected even such ancillary services as agriculture, forestry and medical. They who were to become helpers became *hakims*. The time has come when there should grow a greater sense of unity between the people and the officers. The nation-building departments must win the confidence and trust of the people whose interests it is their duty to serve.

In conclusion, I can assure you it shall be my anxious care during my tenure of office to help you to raise the College and the Institute to a premier position in India, so that the Forest Department may bring more and more areas under its beneficent activities and secure for the people better dwelling houses, a higher standard of living and above all a greater unity of will and purpose with a growing spirit of sacrifice, which is essential if India is to become a Sovereign State and maintain its sovereignty by becoming the protector of all, closing all controversies which have their root in distrust and misconceived ideas of sovereignty. A Sovereign Power, according to an ancient saying fulfils its purpose only when it enables the tiger and the goat to drink from the same fountain and at the same time."

The following agenda were debated:

PART I

(Saturday, the 31st October, 1942.)

1. Increasing the utility of the Forest Research Institute to provinces.
2. Provision of staff at the Forest Research Institute and Colleges. (The demand for education alone has practically doubled in the last year or two but it has recently been impossible to obtain staff from provinces to teach them.)
3. Resolution on item 12 of the Silvicultural Conference, 1939, regarding erosion and forestry in India.
4. Resolution on item 11 of the Silvicultural Conference, 1939, regarding management and improvement of forest grazing.
5. Desirability of establishing Advisory Boards on Forest Utilization in all provinces (Central Advisory Board).
6. Surveys of timber and other forest products. (This is connected with items 7 and 8.)
7. Co-ordination of regeneration policy within and between provinces with special reference to light hardwoods. (Federation of Indian Chambers of Commerce and Industry.)
8. Desirability of appointing an economic botanist in each province.
9. (*a*) Provision of a forest sinking fund for post-war expenditure.
   (*b*) Senior forest officers' conference.

PART II

(Monday, the 2nd Nov., and Tuesday, the 3rd Nov, 1942.)

10. War and post-war policy of the Forest Research Institute.
11. Forest Education.
12. A general co-ordinated study of bamboos.
13. Regulation of fellings after the war to absorb accumulated Army stocks by consumers (Punjab).

The Board had a very interestingly busy time. Papers on various items of the agenda were read and fully discussed. The delegates were also shown round the Institute and the workshops where they saw the war work being done in almost all branches of the Institute. It is a matter of no small gratification to realize that forestry in India is no longer an isolated and little known subject left to forest officers. The association of Ministers of provinces with the activities of the Board is a very welcome change. It is with the Ministers that the final moulding of forest policy rests and it is from them that all changes for the betterment and well-being of forests must come.

SOME OBSERVATIONS ON THE GROWTH AND DEVELOPMENT OF *Dendrocalamus strictus.*

BY S. P. SAHI,

(Late Forest Ranger, Silviculture Branch, F.R.I., Dehra Dun.)

Summary.—This note is an account of some observations on the growth of *Dendrocalamus strictus* at Dehra Dun. It deals with the following points :

I. GROWTH OF BAMBOO CULMS—

(*i*) Rhizomes.
(*ii*) Buds on rhizomes.
(*iii*) Development of a rhizome bud.
(*iv*) Sheaths.
(*v*) Formation of rhizomes.
(*vi*) Formation of culmless rhizomes.
(*vii*) Formation of switches.
(*viii*) Growth of culm above ground.
(*ix*) Completion of height growth of culm.
(*x*) Branching of culms.

II. CAUSES OF MALFORMATION OF CULM—

(*i*) Physical obstruction during growth.
(*ii*) Insect attack during growth.
(*iii*) Physical injury during growth.
(*iv*) Exposure during growth.

III. APICAL INJURY TO GROWING CULMS.

I. GROWTH OF BAMBOO CULMS

(*i*) *Rhizomes.*—The bamboo rhizome is not a true root, but is an under-ground portion of the stem, closely similar in essential structure to the culm and its branches, which form the above-ground portion of the stem. True roots develop from the nodes of the stem, profusely from the closely spaced nodes of the under-ground rhizome, and occasionally from the nodes of the above-ground culm. There are two types of rhizome, *viz.* the culm-bearing rhizome and the culm-less rhizome. The former is the underground system which directly supports a culm above ground, while the latter does not support any above-ground growth. Every rhizome is potentially a culm bearer but, during development, it frequently happens that some mechanical obstruction or other adverse influence is encountered which checks growth, and prevents the production of the above-ground stem which otherwise would have developed. Hence the culm-less rhizome, which is nothing but a repressed form of the

culm-bearing rhizome. Both these types of rhizome bear buds, which in structure and potential development are identical.

(*ii*) *Buds on rhizomes*.—These buds are initially flat in shape, usually less than an inch in diameter, and are covered profusely with scales. These scales are at first not very apparent but develop rapidly as the bud develops and they are in reality the undeveloped sheaths of the future culm. On carefully dissecting away these scales one by one, it can be seen that a bud contains a complete bamboo in embryo. Each bud has as many as 35 or more telescoped internodes with an equal or larger complement of scales (*vide* sketch) in appearance not unlike the growth rings on the stump of a tree, but in the form of a terraced mound (*vide* Plate 1, Fig. I).

(*iii*) *Development of a rhizome bud*.—Those buds on rhizomes which do eventually develop are usually one year old, often two years old, but seldom older than this. They start growth just before the monsoon so that they appear above ground with or during the monsoon. There is no terminal "growing point" in a bud; development of the inter-nodes of the embryo culm in acropetal succession is what actually occurs. The development simply takes place by the elongation of the basal internodes, as seen in a bud, with proportionate development of girth and of the scales attached at the nodes (*vide* Plate 1, Fig. II).

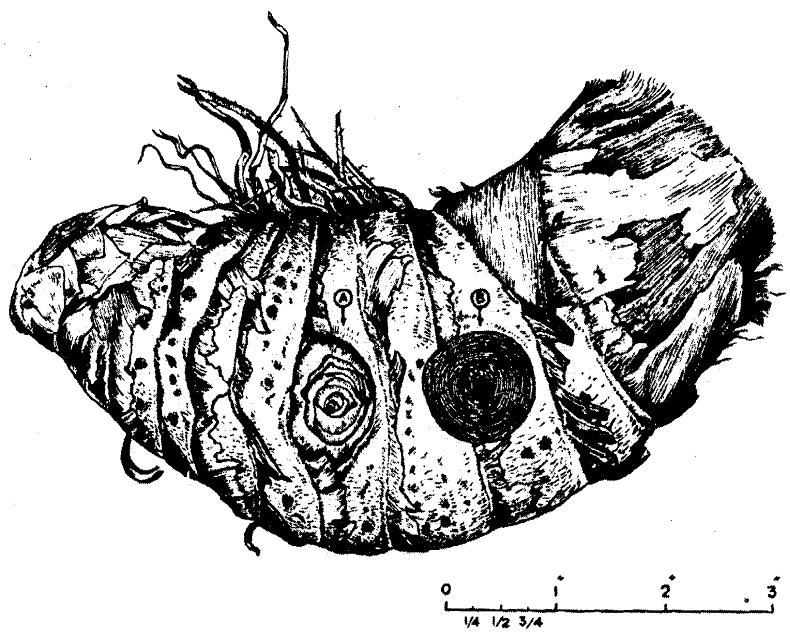
(*iv*) *Sheaths*.—The sheaths are of vital importance to the culm during and before growth. In the rhizome bud they are present as small scales. Each internode is carefully wrapped up in a single sheath but the basal internode has always more than one sheath. In a bud the sheaths are arranged alternately clockwise and anti-clockwise and hence during and after growth they appear wrapped spirally round the stem in alternate directions. The sheath is a nurse to the tender internode and protects the dormant or the growing internode against injury and dessication. Its outer surface is armed with clusters of fine stiff hairs which are detached on the slightest touch and cause irritation to any naked part of the body.

The sheath discharges two functions, namely:

(*a*) to protect the tender internode during and before growth, and

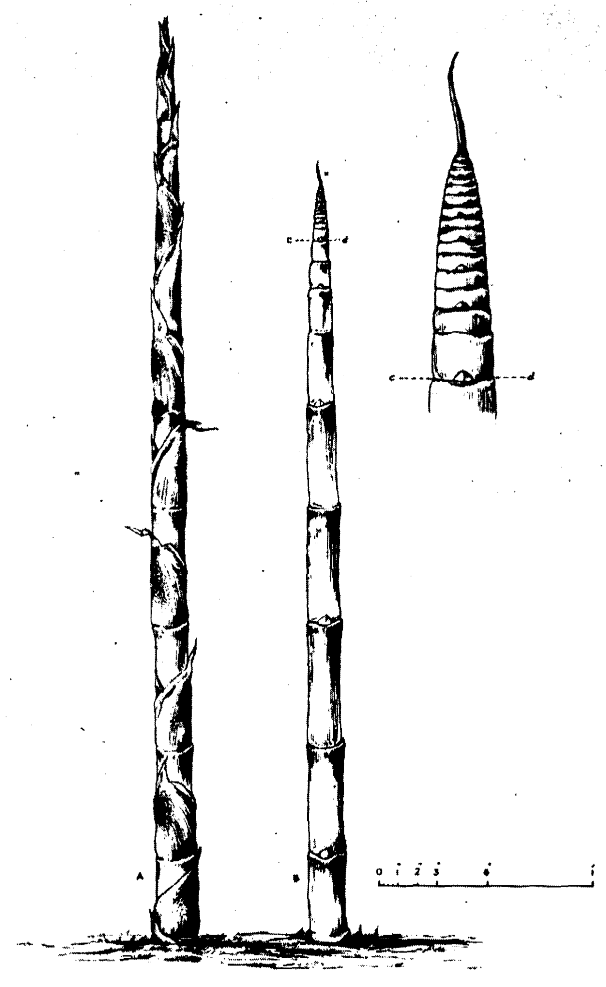
GROWTH OF BAMBOO CULMS

Fig. I.



The underground rhyzome showing two buds A & B. Bud B has been cut across to show internal details.

Fig. II.



The very young culm just starting its growth. B shows the culm with the sheaths removed.

(*b*) to protect the bud of a branch at the node during the period that the tender bud has to lie dormant. This however, does not appear to be a very important function, as even early removal of the sheath has not caused death of the bud at the node. The thing that matters is that the early loss of the sheath appears to cause early development of buds at the node. The bud at the node which is the embryo branch remains quiescent on account of the sheath, to enable all growth activity to be devoted to the elongation of the culm to its full length, before commencing its own growth.

The sheath dies after performing the above duties, but continues to persist even after it is dead for some time, usually one year, until weathered or dropped off when the nodal buds develop into the main branches.

(*v*) *Formation of rhizomes.*—During the development of a rhizome bud into a culm, the first thing formed is a stout new rhizome. Before the culm appears above ground the new growth develops into a complete rhizome for the support of the culm. At this stage it is equipped with several fully grown buds which in their turn lie dormant until the following year. The function of the rhizome is to give support to the growing aerial shoot (culm) and to act as a feeding channel. The feeding organs of a rhizome are the slender rootlets which are capable of going from a few inches to a few feet deep underground. If during digging or otherwise these rootlets are destroyed the rhizome is capable of forming new rootlets in abundance.

(*vi*) *Formation of culm-less rhizomes.*—The period of underground growth is most critical in the life of a culm. At this stage the miniature bamboo is in such a delicate state that any small shock or injury by insects, or mechanical injury may result in the immediate death of the tender growing part. Several buds that were even slightly injured during observations perished soon afterwards. A bud that does not meet any adverse factor underground grows rapidly through the enlarging of the basal internodes which form the rhizome, and then the aerial shoot above ground. If, however, the portion above ground is destroyed after the complete development of the rhizome, such a member becomes a culm-less

rhizome. Disturbances of any kind in the early growth, or any weakness in the bud, give rise to smaller forms of culm-less rhizomes which are often seen as small protuberances on bigger forms of rhizomes. These undeveloped rhizomes are usually inactive members of the rhizome-system, as they bear neither buds nor rootlets. They often perish later on. On the other hand an active culm-less *rhizome is a rhizome which after completing growth of the underground* portion of the stem fails for some reason to develop the aerial shoot. Such culm-less rhizomes bear active buds, and well developed roots which take an active part in supplying water and food to the parent clump.

The chief causes of the presence of culm-less rhizomes in a clump are:

(*a*) Any form of injury or shock to a partially-grown rhizome which results in the apical portion being killed.

(*b*) Very slow growth of a bud caused by a weakening effect due to either its parent being a culm-less rhizome, or there being several buds developing simultaneously from one culm-bearing parent rhizome.

(*c*) The late development of buds which reach above ground to face a hot and unfavourable weather condition after the monsoon, resulting in the death of the remaining undeveloped portion of the culm, the separation of which from the rhizome leaves a cup-shaped projection at, or just above ground level.

Any bud not handicapped by the factors enumerated above develops to bear a culm. A perfectly healthy bud from a healthy parent stock gives rise to a normal-sized culm. But in a clump one also finds undersized culms which are called whippy shoots or switches.

(*vii*) *Formation of Switches.*—The thin and undersized appearance of a culm suggests poor nutrition. The chief causes of the presence of switches appear to be:

(*a*) Development of a bud on a culm-less rhizome.

(*b*) Development of several buds simultaneously from one parent culm-bearing rhizome.

(*c*) Development of a bud in a congested or unhealthy part of the clump.

(*d*) Late development of a bud that thus has to carry on further growth at the unfavourable climatic season.

(*viii*) *Growth of culms above ground.*—As already stated above, a bud is a complete miniature bamboo with a rhizome and a culm, so similarly a culm above ground is a complete aerial shoot, irrespective of its size. New growing culms 6in., 1 ft., 1½ ft., 2 ft., 3 ft., 4 ft. and 5 ft. high when stripped of their sheaths all disclosed 30 to 35 internodes (*vide* plate 1, fig. II). The actual number of internodes was probably more as the topmost region contained very fine sheaths which could not be separated and counted satisfactorily. *There is no terminal bud in a culm and consequently no terminal growth.* The height growth of the culm is caused by the successive elongation of the internodes.

The lowest internode at the ground grows first and the topmost one the last of all. Several internodes from the bottom upwards grow simultaneously. It is not possible to say precisely how many internodes grow at a time, or the period during which internodes complete their growth. The internodes are most carefully wrapped up in sheaths and the whole of a new culm up to 5 ft. or even higher looks like a continuous mass of sheaths. The internodes though developing are concealed within the sheaths. It is usually after the internodes have completed more than 3/4 of their height that they become visible above the edges of the sheaths. Close watch was kept to note the emergence of internodes from the sheaths. Several hundreds of freshly emerging internodes were observed and measured, and it was found that elongation was normally complete within one to four days from the time the internode first became visible above its sheath. The daily increase in length of the internodes during this period averaged from ½ in. to 3 in., with about 1 in. per internode per day as a general average. These observations were confined to about the first 10 internodes above ground level.

The following figures show some of the maximum growth (in inches) put on by individual nodes in 24 hours:

$4\frac{1}{2}$	to	8	*i.e.*	$+ 3\frac{1}{2}$
$7\frac{1}{2}$	,,	10	,,	$+ 2\frac{1}{2}$
5	,,	$8\frac{1}{4}$	,,	$+ 3\frac{1}{4}$
6	,,	$8\frac{1}{2}$	,,	$+ 2\frac{1}{2}$
6	,,	10	,,	+ 4
$4\frac{1}{2}$	,,	8	,,	$+ 3\frac{1}{2}$
5	,,	$7\frac{1}{2}$	,,	$+ 2\frac{1}{2}$
6	,,	9	,,	+ 3
5	,,	8	,,	+ 3

In order to find out the rate of growth, a 2 in. long internode was exposed on one side by cutting out a portion of the sheath. The following table shows the rate of growth:

Table to show changes in the rate of growth of an internode with time.

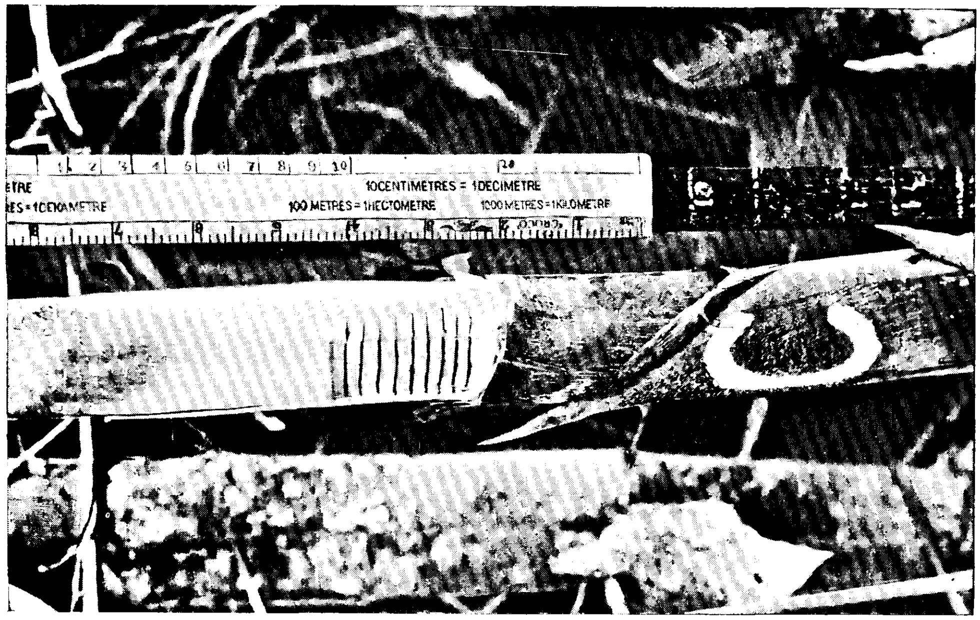
Initial length.	Length in inches recorded after					
	1 day	2 days	3 days	4 days	5 days	6 days
2 ..	2·85	3·75	4·75	5·6	6·3	6·5 (growth ceased).
Current daily increase ..	0·85	0·90	1·0	0·85	0·7	0·2

Note: It is necessary to mention here that the early exposure of the internode resulted in the stunted growth of the internode as the internodes next below and above this one grew twice as long.

With a view to determine the most active growing part an internode was carefully and lightly marked into 10 equal parts of 0.2 in. each. It was found that the upper parts of the internode completed growth first and activity later on was confined to the

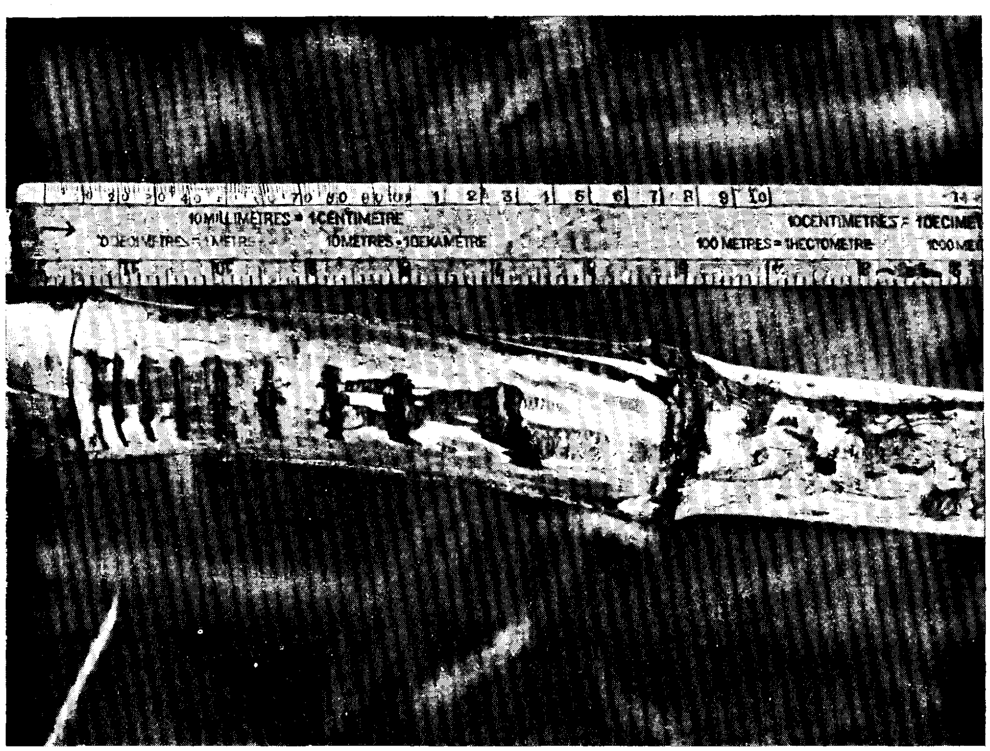
GROWTH OF BAMBOO CULMS

Fig. I.



A growing internode with part of the sheath removed. It has been lightly marked with 10 divisions, each 0.2 inches apart.

Fig. II.



The same internode as in Fig. III. 6 days later. Owing to the exposure caused by removal of the sheath to mark the internode its growth was stunted and only about half that of the internodes above and below it.

lower regions, which continued growing until maximum growth was reached. The following table gives details of measurements:

Table to show rate of growth at different parts of an internode (*vide* Plate 2, Figs. I & II).

Divisions Top to bottom.	Initial width	Width in inches recorded after					
		1 day	2 days	3 days	4 days	5 days	6 days
1 ..	0·2	0·2	0·2	0·2	0·2	0·2	0·2
2 ..	0·2	0·2	0·2	0·2	0·2	0·2	0·2
3 ..	0·2	0·3	0·3	0·3	0·3	0·3	0·3
4 ..	0·2	0·35	0·35	0·35	0·35	0·35	0·35
5 ..	0·2	0·35	0·4	0·4	0·4	0·4	0·4
6 ..	0·2	*0·4	0·5	0·5	0·5	0·5	0·5
7 ..	0·2	0·3	*0·6	0·7	0·7	0·7	0·7
8 ..	0·2	0·25	0·4	*0·7	0·8	0·8	0·8
9 ..	0·2	0·25	0·4	*0·7	*1·1	1·25	1·25
10 ..	0·2	0·25	0·4	*0·7	1·0	*1·6	*1·8 Growth ceased.

***The daily point of most rapid growth is marked with an* ***

NOTE :—The top 2 sections of the internode had completed their growth before the marking was done.

Although it is not possible to be definite about the period taken by an average internode to complete its growth yet it can however be assured that completion of elongation takes place within a few days, say about a week. More than one internode is growing at one time but the number of such internodes growing simultaneously is limited to about 5 to 8 (not counting those which are growing unobtrusively within the sheaths).

(*ix*) *Completion of height growth of culms.*—Culms grow very fast. In the early stages the rate of growth is slow, about 4 in. to 6 in. per day. After the culms have reached 8 to 10 ft. high they start shooting up very fast, often 12″ in 24 hours, and cases were not rare in which the increment recorded was nearly 24″ in 24 hours, *i.e.* 1″ per hour. This fast rate of growth was noted in most cases to continue for a little more than a month, the rate of height increment then falling considerably to a few inches per day. At this stage, the recording of daily height growth became a difficult task not only because the active operation of height measurement became difficult but primarily because the culms with tapering tendencies had curved over in the upper parts of their height growth. This

not only rendered recording of height growth difficult but also the figures, less reliable. The longest internodes are usually confined to the middle 1/3 of a culm.

(x) *Branching.*—Branching usually starts when a culm is nearing the completion of its height growth.

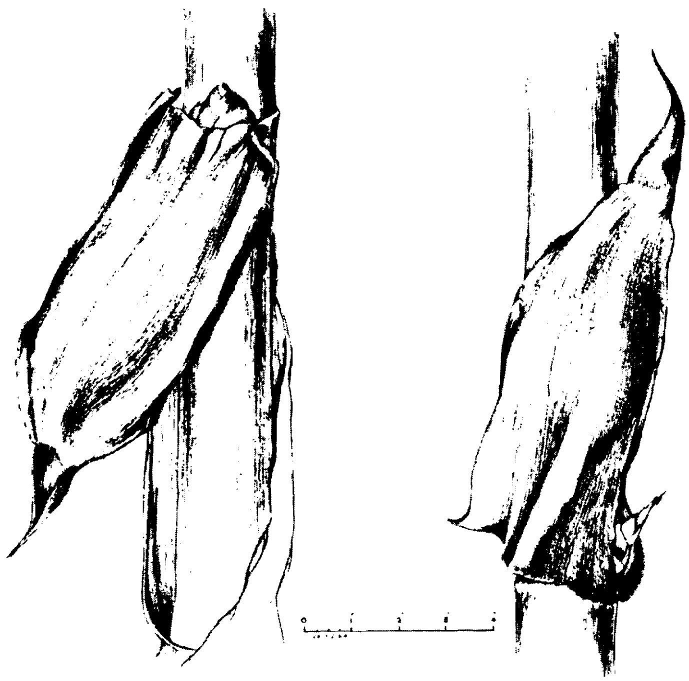
The opening and development of buds normally starts from the bottom and proceeds towards the top. This order of acropetal succession, however, is not strictly maintained. Very often it has been noticed that branching has already commenced in the upper nodes while the lower nodes have not yet started branching. In the case of immature bamboo crops (about 4 years old from line sowings) it has frequently been seen that the topmost branches develop much ahead of those at the bottom or those at the middle.

The principle of the development of branches is the same as that of the culm; while the origin of a culm is a bud on a rhizome underground, that of a branch is a bud at the node of a culm above ground. As in the case of a rhizome bud, on examining buds at the nodes, 25 to 30 or sometimes more internodes were revealed neatly enclosed by scales, which are the would-be sheaths of a future branch-culm. The only difference between a rhizome bud and a node bud is that while the former contains one single shoot, the latter invariably contains one main central bud with several smaller auxiliary buds on the sides, except that sometimes the bottom-most 1 to 3 nodes may contain a single shoot bud. The bud at the node looks at first sight to be a single-shoot bud, but on examining it closely by removing one or more scales, several buds one inside another were disclosed.

The most important of all node buds is the main central bud which forms the important lateral branch shoot. As in the case of the culm, this also grows by elongation of the internodes. It also contains similar buds at its own nodes, which grow in a similar manner, to form branchlets. These branchlets also grow like the culm or their parent lateral branch and contain similar buds at their nodes, which are responsible for further branching and re-branching, though their sizes from successive parents are considerably reduced (*vide* Plates 3 and 4).

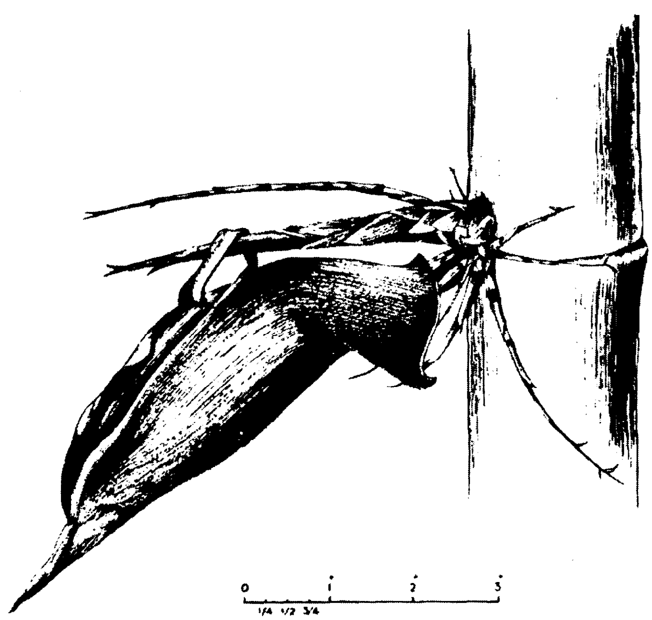
BRANCHING OF BAMBOO CULMS

Fig. I.



Early development of the bud.

Fig. II.



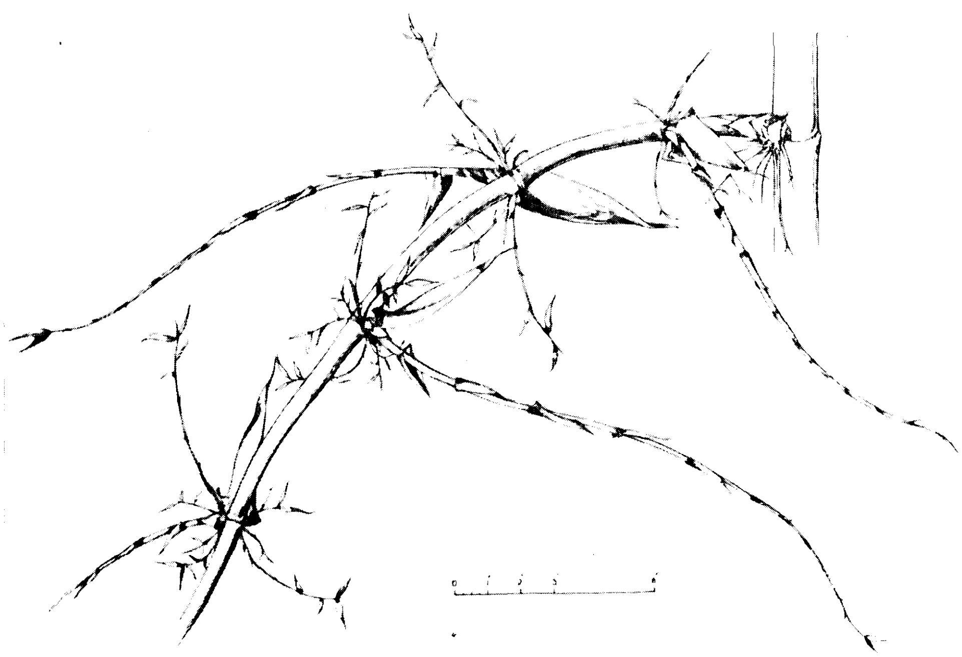
Early development of the primary branch.

BRANCHING OF BAMBOO CULMS

Fig. I.

Later development of the primary branch showing the beginnings of the secondary branches.

Fig. II.



Primary branch complete, secondary branches well developed, tertiary branches just starting to grow.

II. CAUSES OF MALFORMATION OF A CULM

One of the characteristics of congestion in a clump is the malformation of some of the culms. Hence studies of the causes of the culm malformation were made.

In an area of one acre containing about 400 clumps, 100 malformed culms were found and these were studied intensively. In all these observations the cause of the malformation was in every case obvious and not a single case was found in which the malformation appeared to be hereditary. The main causes of malformation were some form of physical injury or obstruction during the growth of culms. Among the many malformed, twisted or bent growing culms under observation, none was found free of defect, though apparently from the outside many of them appeared to be perfectly sound in condition. The following were the main causes of malformation:

(*i*) Physical obstruction during growth.
(*ii*) Insect attack during growth.
(*iii*) Physical injury during growth.
(*iv*) Exposure during growth.

(*i*) *Physical obstruction.*—A growing culm is very vigorous and usually exercises great power to release itself from any obstruction present. This is why culms in a clump are usually straight even though a clear passage upwards is not apparent, due to masses of lateral branches. If the obstruction is too persistent the culms have to yield and this results in the direction of growth being diverted.

There are two forms of physical obstruction:

(*a*) overhead or top obstruction, and
(*b*) side obstruction.

(*a*) *Overhead obstruction.*—When the obstruction overhead is so unrelenting as to prevent upwards or sideways movement of the culm, it results in the culm being bent or twisted, at a lower portion of the growing part of a culm which was originally upright. In a clump the chief causes of overhead obstruction are:

(1) persistent lateral branches in dense parts of a clump, and
(2) contacts of more than one older culm, which form arches above the growing culms.

(*b*) *Side obstruction.*—This is chiefly caused by lateral branches on the growing culms. An unmutilated lateral branch is pliable and may often relax and allow the growing culm to continue elongation. In the case of a cut or damaged snag of such a branch, it invariably offers strong resistance, but because its overhead surface is limited it is not capable of suppressing growth, and therefore only causes the growing culm to change its course at this point which later appears in the form of a kink.

An attempt was made to cause top obstruction to several growing culms by placing earthen barrels suspended a few inches above the tips of the culms. The barrels were supported and tied to stick ends, the lower ends of which were thrust deep into the ground and well rammed in order to make them rigid (*vide* Plate 5, Fig. I).

Twenty-four hours after the application of the treatment the culms had all bent considerably at a lower point of the culm which was previously straight. At this stage some of the culms were released from their top obstruction. Three days after the release the culms had straightened themselves and continued further growth as though nothing had happened.

Another culm which was released after four days' continual top obstruction was found to be incapable of straightening itself (*vide* Plate 5, Fig. II).

From the above experiments, the following may be concluded:

(1) That an obstruction can cause bending or twisting of the lower portions of a culm which were originally straight, giving a false impression that the culm took a turn or bend at the time that the culm was at that height.

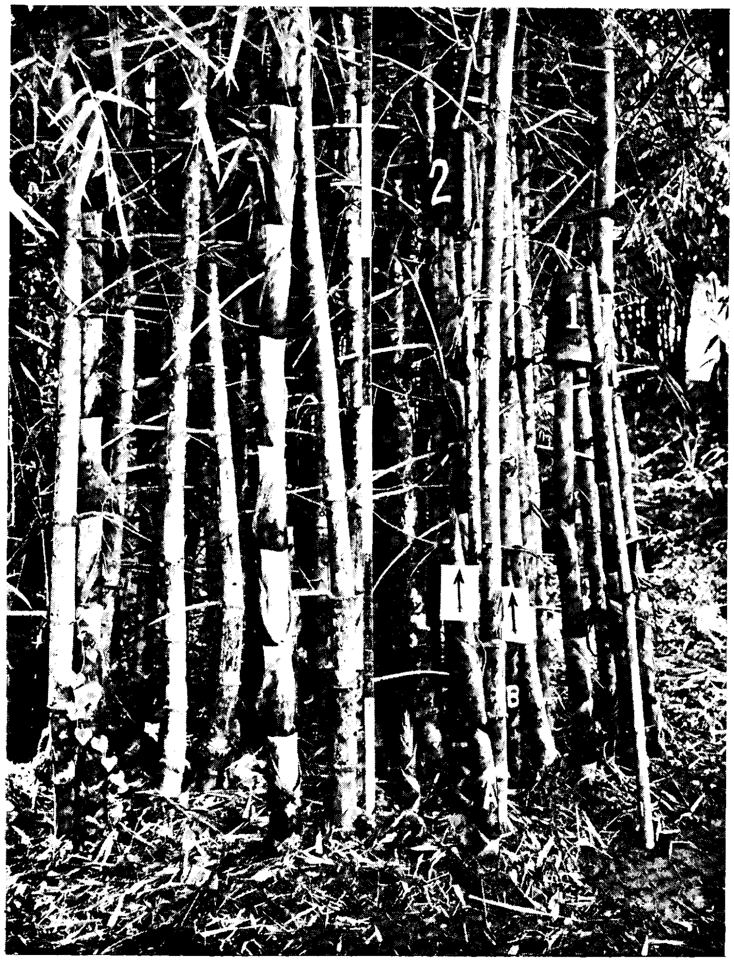
(2) That a bend, twist or kink is capable of straightening itself if the obstruction is relaxed while the internode or internodes at that point are still growing actively.

(3) Any obstruction overcome after the tissues at the bent point have ceased growth results in a permanent malformation.

(*ii*) *Insect attack during growth.*—A mild form of insect attack has little effect. Malformation only takes place if the insect damage is serious. Insect attack of a serious nature causes malformation

MALFORMATION DUE TO OBSTRUCTION OF GROWING CULMS

Fig. I.



Culms 1 and 2 were obstructed by pots firmly pegged to the ground.

Fig. II.

As Fig. I, but 8 days later. Culm 1 was released on the 2nd day and straightened itself. Culm 2 was released on the 4th day and never straightened itself.

only if such an attack has taken place during the actively growing period of an internode. Insect attack however serious, if it takes place after the elongation of the internode is already over, does not affect culm shape. In an insect-attacked culm where bending has taken place, it is to be noted that the bend is always inclined towards the side attacked. During early stages of the growth of a culm such a bend looks much exaggerated but with further growth of the culm the upper portions straighten themselves, and the portion early affected looks nothing more than a mere kink.

(*iii*) *Physical injury during growth.*—There are other reasons such as damage to developing culms by monkeys or other animals, or forms of mechanical injury caused during felling at periods when growth of new culms has started, which react in the same way as a wound caused by insect damage.

In order to study this effect, artificial wounds were made at the growing internodes of some of the new culms. They all bent at these points and the effect was conspicuous about 2 to 4 days after making the injury. As already stated in the case of insect damage above, the direction of the bend in this case also was always towards the part wounded.

(*iv*) *Exposure during growth.*—This is not common. It only happens if the protection scales are damaged or stripped off during the growth of the internodes. In one growing culm 5 ft. high all the scales were stripped off leaving the tender internodes exposed but intact. Within a few hours of this, the effect was seen. The naked culm which was at first straight became wavy. Thereafter though no further growth of the culm took place in height or in diameter, the tissues got hardened and the culm continued to survive in a stunted form, although the mass of rudimentary internodes at the top, and all their immature buds were killed. Removal of sheaths at so early a stage did not kill the buds at the nodes of the surviving portion of the culm. They developed immediately, premature to their usual habit, and formed normal-sized persistent branches which appeared large for the dwarf culm,

III. APICAL INJURY TO GROWING CULMS

As stated above, a growing culm is very hardy to adverse conditions. This is due to the fact that the tip of the culm is profusely covered and protected by sheaths and the topmost internode, which remains in a rudimentary form until its turn comes last of all for elongation, is securely embedded several inches below the visible tip of a culm, usually 4 in. to 10 in. (*vide* Plate 1, Fig. II). With such a secure position, if any immediate injury at the tip of a growing culm takes place, the brunt is borne by the sheaths and their partial damage does not affect the safety and growth of the culm.

A 3 ft. high growing culm was cut off 8 in. from the top thus cutting several sheaths and severing about 15 of the topmost internodes. This beheaded culm continued growth at an average daily rate of 6 in. till the last upper internode left intact completed its growth.

Another 6 ft. high growing culm was cut off 4 in. from the top. In this case only 4 in. of the sheaths were destroyed and the culm proper was untouched. This culm grew normally to be a full-sized lofty culm shooting at the rate of 9 in. to 13 in. per day. The only effect of the cut was shown by a few of the sheaths in the middle of the culm which were partially cut, but making no difference in their normal functions, nor causing premature branching.

Note by the Silviculturist:

The above note was written by Ranger Sahi in December, 1940, just before he left for the army. It is published now owing to the great increase in interest in bamboo growth that has been aroused in recent months by war problems.

SANDALWOOD REGENERATION IN SAMBRANI RANGE IN THE KANARA NORTHERN DIVISION

BY S. V. GULWADI

(*Range Forest Officer, Sambrani.*)

Sandalwood (*Santalum album,* Linn.) is a root parasite and requires a host plant to live and flourish upon. It is a moderate-sized evergreen tree with shining green leaves but never found in the evergreen forests (*Kans*). Sandal trees are sometimes found on the outer fringes of opened-out *kans* like Hosur near Siddapur or Kangod near Sirsi, where Hangami Lagan plots have been disforested for cultivation or residence or for providing *benas* (elbow-room) to prevent pressure of forest growth near cultivation or given out as *bettas* (Forests assigned to rice and garden lands in Sirsi-Siddapur Range to provide *soppu* leaf manure for cultivation), notably in Kangod, Margudi, Kansur, Shiralgi, etc. But I have never seen sandal growing in the heart of evergreens like Mavingundi *kan* or the *kans* extending along the Gersoppa Ghat. This might be due to the following factors:

(1) Excessive moisture which causes the fallen seeds to rot.

(2) Exceptionally heavy undergrowth consisting of canes, palms and other herbacious plants which smother the seedling, if any, and kill out by root competition.

(3) Heavy layer of humus which prevents the seed dropped from reaching the soil.

(4) The close canopy of the big giants completely shutting off the overhead light and free circulation of air.

(5) The majority of species like *Myristicas, Holigarna, Garcinias, Calophyllum, Eugenia,* mango, *Artocarpus,* etc., being unsuitable hosts (associates) with heavy crowns causing considerable drip.

It is a common experience even in open tracts that sandal is never found in association with, or uder mango, *phanas* or *jambol.*

Distribution of Sandal.—Sandal is usually found in the open tracts of forests adjoining natural sandal belts. I have seen it grow in Coimbatore, in the Nilgiris (Kargudi) in Salem (Denkanikotta) and in the Mysore territory—the home of sandal. It must have spread from these tracts, especially Mysore, to the adjoining areas of

Dharwar. Bijapur Division (Hangal, Hirekerur) and parts of E. D. Kanara—notably Sirsai, Siddapur, Mundgod and thence further on. Even in these parts sandal grows more profusely in the eastern half of Sirsi-Siddapur, Mundgod and Haliyal. A glance at the map will show that this is so because of the proximity of areas where sandal has established itself. It decreases as we go west and disappears altogether as the ghats are reached either in the evergreen forests of Gersoppa, Nilkund or Devimane or the vast deciduous teak forest of Haliyal and Yellapur.

Types of forests and localities.—In the Southern Circle sandal is mostly found in the fuel areas of Dharwar-Bijapur Division, inferior pole and fuel forests of Belgaum Division (Khanapur and Gujnal), Haliyal and Mundgod; probably because of the presence of mother trees in the adjoining districts from where the seed must have been scattered by birds as the sandal fruit is edible and very much liked by the birds. (Sandal, like loranthus, is mostly spread by birds. It is also possible that the presence of suitable hosts, primary and secondary, such as *lantana, Carissa carandas, Acacias, Albizzias* and *Zizyphus* and many other spinous and light leaved species have encouraged its dissemination. Thirdly, it might be due to overhead light and free circulation of air in these forests. In these areas there is very little leaf fall to feed fires and thus destroy all seed dropped by birds which normally may happen in the case of the High Forests of teak and bamboo. In the High Forests, moreover, there is much heavier undergrowth which gives shelter to destructive animals like rodents, squirrels, rabbits, etc. These animals destroy the seed as well as the seedlings of sandal. Finally, the stunted and inferior growth, with predominant spinous species, prevailing in these poor forests indicates superficial soil with hard ground underneath which tends to develop lateral root system, thus helping sandal to establish haustorial connections with them. It is also possible that since most of these areas are worked on simple coppice system the young and vigorous roots of the coppice growth might be giving additional nourishment to the sandal. In Sirsi-Siddapur, however, I have seen sandal growing in all types of forests, *viz.* (1) Minor forests, (2) Deciduous forests, (3) Semi-evergreens, and (4) Evergreens when given out as *bettas.* Even here sandal seems to prefer hedges along the fields, roadsides, *bandhs* of

tanks, open *kumki* areas (strips) called *benas* round cultivation containing much hacked tree growth and grazed by domestic animals; localities near big tanks like Gudnapore or perennial streams like Wardha river near Banvasi; abandoned cultivation, deserted villages and *betta* forests. One common feature in all these areas being the working of soil by human agency and overhead light. The profuse growth of sandal in Sirsi-Siddapur Range which is certainly on the increase may be attributed to the following causes:

(1) This Range touches the Mysore frontier all along with plenty of natural sandal.

(2) Presence of suitable hosts, as the vast area of forests extending over two *talukas*—approximately 664 square miles, contains all types of forests having a variety of species, at least some of which are agreeable to sandal.

(3) It is not one continuous block of forest but throughout interspersed by vast gardens, cultivation and villages (some of which are abandoned), which attract a number of birds. Large tracts of forests given out as *bettas* are usually the forests adjoining gardens, and cultivation and in many cases protected by owners all round by fencing or planting *Ageva americana* or by a moat, the undergrowth is cleared for vegetable and fruit cultivation and the upper leaf canopy is thoroughly opened up by heavy loppings.

In fact some of these *bettas* contain the best sandal and the majority of them have a profuse regeneration of sandal. Even in typical evergreen localities beyond Bilgi, Itagi and Kansur, though sandal is absent outside, it is seen sparsely in these *bettas*. I believe it must be due to the shelter these *bettas* give to birds and the opening up of the forest, both upper and lower canopy, giving more light and air circulation and the fencing which gives protection from wild animals and their browsing, and also protection from fires. Some of the biggest sandal trees I have seen in Sirsi-Siddapur were found in semi-evergreen forests or *bettas* right up to 40 ft.—45 ft. in height with a girth of 44 in. at breast height, almost looking like *matti* (*Terminalia tomentosa*) growing in water-logged areas

with dark brown (almost black) bark with slight longitudinal and transverse cracks.

Soil and rainfall.—Natural sandal is found growing in fair amount in Bagalkot and Badami Ranges with a rainfall of 20 in. to 25 in. in stony and gravelly soil but it is also found growing in *Kurans* along rivers in black cotton soil or in abandoned *gavthanas* and *malki* lands. I have also seen some very good sandal growing in the alluvial soil thrown up on the banks of the Wardha river between Banvasi and Tigni; also on the sea coast in sandy loam between Honavar and Bhatkal with a rainfall of over 100 inches. But in most parts such as roundabout Tegur and Dharwar, along Haliyal or Kalghatgi side, it is mostly red gravelly soil with 30 to 35 inches rainfall. In Sirsi-Siddapur, however, it is found in all types of soil and the rainfall varying from 40 to 45 inches in Dasankop Banvasi side to 100 to 120 inches in Siddapur and its surrounds. I have seen sandal even in Bilgi, Itgi, Havinbilu which are 8 to 12 miles west of Siddapur and must be having a rainfall of not less than 100 to 120 inches. Hence it may safely be stated that it is not the soil or rainfall which is so important to sandal propagation as the primary and secondary host plants, protection of the seed and the seedling from the wild animals like rodents, etc., and protection from fire, damage, browsing and overhead light. Given these, it will thrive anywhere.

Associates.—We usually find sandal associated with a certain number of species and showing preference for *Azadirachta indica, Feronia elephantum, Zizyphus* species, *Erythrina indica, Pterocarpus marsupium, Pongamia glabra, Cassia siama, Acacia concinna, Acacia arabica, Acacia intsia, Albizzia lebbek, Albizzia odoratissima* and *Albizzia amara, Anogeissus latifolia, Randia* spp., *Strychnos nuxvomica, Lantana, Carissa carandas, Jatropha curcas* and even sometimes bamboo. I have seen sandal growing in isolated bamboo clumps near Banvasi and Tigni but not in wholesale bamboo areas like Bhagwati High Forests.

Propagation of sandal.—Hence if attempts are to be made to establish and propagate sandal we must try to give it all the conditions prevailing in nature artificially. There is no point in trying to establish wholesale plantations of sandal like those of teak as its

silvicultural requirements are quite different from those of teak. As such, it is best if small groups of sandal are raised in fuel and pole area coupes depending on birds to spread them as in nature. This will facilitate control as well as supervision and immensely increase the potential value of our forests.

This is how it is done:

(1) *Broadcast sowing*.—A handful of good sandal seed is sown broadcast under suitable *lantana* and other thorny bushes just before the south-west monsoon starts, in various places allowing nature to establish regeneration. I have tried this method in Sirsi-Siddapur Range in Bachgaon, Heggar, Tigni and Yekkambi Sandal regeneration plots but with practically no results, all seed being destroyed by rodents.

(2) *Dibbling*.—Dibbling selected sandal seed under *lantana* bushes in holes pricked by bamboo sticks and covering them with light soil at the beginning of monsoon. This method I have tried in the Sample plots and Regeneration plots in Sirsi-Siddapur—in Bachgaon, Heggar and Yekkambi. The result was about 2 to 5 per cent. regeneration at the end of the rains. This even never survived the hot weather.

(3) *Transplanting*.—Transplanting of seedlings 4 to 6 inches high from forests and *malki* lands grown under mother trees in the same 3 plots with a ball of earth gave a success of about 25 per cent. at the end of the monsoon. This was the only method followed there. Some casualties occurred during the hot weather. Some of these successful plants were as high as 2 ft. to 2½ ft. at the end of the first year. Some of the flourishing young plants in Bachgaon plot have been raised by this method.

There is one acre sandal plantation in Bachgaon which is apparently very successful. This one acre was clearfelled, burnt partially and sandal was transplanted under young *lantana* coming up after rains. Two-thirds of the area of one acre is full of healthy sandalwood trees now 10 to 12 ft. high with a girth up to 12 inches; but some of these have commenced dying from top and show no sign of further progress. This appears to me to be due to the insufficient food obtained from the *lantana* bushes and the toxic effect *lantana* is said to exert on sandal. Secondly, the planting being too close, the trees have commenced inter-parasitism killing out the weaker

ones. Finally, heavy growth of soft wooded species, like *Trema orientalis,* completely over-topping it, deprives sandal of considerable overhead light.

But the best and most successful method of regeneration of sandal so far seen by me appears to be the one now followed in Sambrani Range, where sandal regeneration at present is confined to Haliyal Teak Pole Blocks III, IV, V and VI. There is practically no natural sandal in this tract except a few trees in Block VI near Gundoli and a few in Block V near Dodkop but these have not caused any spread of the species near about, hence artificial groups of sandal are raised in clearfelled coupes. This forest mainly contains the following species—teak, *dindal, matti, heddi, kalam* and *channang* (*Lagerstroemia parviflora*) with an undergrowth of *Dendrocalamus* with a few bushes of *handia* and *lantana.*

Collection of sandal seed.—Sandal seeds profusely twice a year —once during the cold weather in November-December, and again in March-April. Good ripe seed, most of it eaten and dropped by birds under mother trees is collected in January and weathered by drying in the sun for a fortnight. Then it is stored in air-tight tins. No other treatment is given to the seed.

By the end of April, after the coupe is clearfelled and all saleable material removed by the contractor, the brushwood and debris left over is collected into suitable groups 66 ft. × 66 ft. (so long 50 ft. × 50 ft.) square and burnt. These groups are staked 9 ft. × 9 ft. or 12ft. × 12 ft. and the weathered sandal seed is dibbled on four sides of the stakes at about 6 inches from it in the first week of May. Earth is first raked to a depth of 2 inches and in the soft earth, 3 to 4 seeds are placed on each side and lightly covered with soil. In the third week of May, after a shower or two, *Calotropis gigantia* seed is dibbled 6 inches outside the sandal dibbling on all the four sides of the stakes. At the same time *Cassia siamea* seed is dibbled in the centre near the stake as well as between the stakes, at intervals of $4\frac{1}{2}$ ft. × $4\frac{1}{2}$ ft. or 6 ft. × 6 ft. according to the planting distance of sandal either 9 ft. × 9 ft. or 12 ft. × 12 ft. *Cassia* is also dibbled close 6 in. × 6 in. apart along the perimeter of the group.

Calotropis begins to sprout within 4 or 5 days and *Cassia* within 8 to 10 days. Sandal takes about 2 months or even more to germinate and by the time the young sandal comes up, the *Calotropis* plants are about 6 in. to 8 in. and *Cassia* about 6 inches. The whole group is protected in the first and second year by a bamboo fence about 6 ft. high, which protects it from being browsed. Thus *Calotropis* with its succulent superficial root system serves as a primary host or wet nurse and helps the sandal to grow vigorously in early life and later on, after a year or so, the profuse growth of *Cassia* gives it scope to form haustorial connections and serves as a permanent host. *Calotropis* is necessary because it gives greater protection and quickens the growth of sandal. Sandal raised in pure *Cassia* shows lesser growth and greater mortality.

Weeding.—In the first season when the group is still open, grass and other herbacious weed growth and creepers are removed by hand twice or thrice during the rains according to the nature of growth, care being taken not to disturb the sandal. By November-December the sandal plants grow up to 2 feet and *Calotropis* up to 4 to 5 feet, and the *Cassia* plants 3 to 4 feet; by the end of one year, that is at the close of the hot weather, sandal plants grow 5 to 6 feet in height, *Calotropis* about the same height and *Cassia* from 8 to 10 feet. Sandal requires added protection during the first two years of its life and *Calotropis* provides it with the necessary amount of shade and protection from the scorching rays of the sun during the hot weather. After the second year *Cassia siamia* grows profusely and lightly closes the canopy and *Calotropis* dies out, leaving the healthy rusty brown saplings of sandal to come up vigorously. In the second year no weedings are required but only lopping of some branches of *Cassia* if they prevent overhead light as sandal prefers overhead light though it tolerates side shade.

This combination of *Calotropis* and *Cassia* not only helps sandal to grow quickly but also suppresses rank growth of grass and other noxious weeds and creepers and prevents root competition in early stage of sandal. Sandal is rarely seen in grassy areas like Bhagwati. I have raised several groups of sandal by the above method in coupe 7 of Blocks III and IV during 1940-41 and have obtained 100 per cent. success. The groups are fully stocked (sandal

having come up at every stake in the group) and the best height in June was 6 feet and the average 4 feet, and all the plants in excellent vigour. I have also raised a similar patch of sandal in the 1940 Bhagvati High Forest plantation (where rainfall is about 75 to 80 inches) under pure *Cassia siamea;* it is quite successful as regards stocking but the height growth and vigour of the plant is decidedly inferior to that of the Pole Area groups, the best plant in June being up to 4 feet with an average of 2½ feet.

Fire protection.—At the close of the rains a strip of grass 6 to 8 feet in width is scraped with *powrah* along the perimeter of the groups outside the bamboo fence and early burning is done in the whole area of the coupe. This prevents fires getting into the coupe, and even should a chance fire occur the cleared strips around the groups prevent fires getting into them. After 2 or 3 years the bamboo fence also crumbles down but the *Cassia* planted close along the perimeter of the group inside the fence during the first season serves as a living wall and protects the sandal sapplings from *cheetal, sambhar* and *bhekar* as well as from strong winds.

I have watched this method of raising sandal successfully during two seasons now; but, even sandal patches raised by the very same method in the past 7 years in this Range are flourishing and showing progressive growth.

The height and girth of some sandal plants in these groups in older coupes will give an idea of its success. Block VI, coupes 1 and 3, contain 7 and 5 year old groups respectively. In coupe 1 the plants are 18 to 20 feet in height with 8 inches to 10 inches girth, the best being up to 12 in. in coupe 3, 15 to 18 feet in height and 5 in. to 8 in. girth, the best being up to 10 inches. Block III, coupes 1 and 2 contain 7 and 6 year old groups respectively. In coupe 1 the height of the plants is 17 to 18 feet with a girth up to 13 in., while in coupe 2 the height is 10 to 12 feet and girth up to 8 inches.

Similarly in Block IV, coupe 5, 3 year old and Block V, coupe 4, 4 year old groups are extremely good with height up to 13 feet and girth up to 8 inches. Thus these groups will serve as centres of distribution from which adjoining forests will be enriched by the spread of sandal by birds.

Fig. I.

The Chinese Kiln.

Fig. II.

The Paraboloid Kiln, various stages.

THE CHINESE CHARCOAL KILN

M. D. CHATURVEDI, I.F.S.

Summary.—An underground kiln of the shape of a rectangular ditch measuring 12 ft. × 5 ft. × 6 ft. holding exactly half a *chatta** of fuel was tried in the Pilibhit Division for the manufacture of charcoal. The ditch was covered with iron sheets rendered air-proof with the help of fine earth. A system of inlet flues and exhausts was devised to control carbonisation. The kiln carbonised wood in about 48 hours, cooled in about 30 hours and yielded charcoal of excellent quality weighing about 20 per cent. of the wood used.

The disappearance of petrol has riveted public attention to its substitutes, the chief among which is producer gas charcoal. The importance which charcoal has assumed of late justifies careful investigation of various types of kilns used for its manufacture.

A kiln, which originated in China centuries ago, was recommended for trial by Mr. D. L. Sah, the Charcoal Officer, U.P. known as the Australian kiln, due to its coming to us through Australia, it seems ideally suited to the conditions obtaining in this country.

Experiments carried out with regard to its size, the speed of carbonisation and costs led to the evolution of a kiln, which yielded excellent results. Described briefly the kiln as perfected in the Pilibhit Division (*vide* fig. I, plate 6) consists of a rectangular ditch 12 ft. long by 5 ft. wide and 6 ft. deep. The cubical contents being 360 c.ft., it holds exactly half a *chatta* of fuel. Iron sheets (plain or corrugated) cover the ditch, dry fine earth making the joints airproof. A system of flues and exhausts regulates carbonisation in a limited supply of air. A detailed description of the kiln and mode of its operation are given below:

(*i*) *Site.*—Any well-drained site not liable to be inundated may be selected for the purpose. In excessively sandy soils, the sides tend to fall in; clayey loams prove most satisfactory.

(*ii*) *Kiln.*—Any earthworker can dig the ditch of the required dimensions. The only skill required is in the making of exhausts and flues. It costs 12 labour days to make a kiln, *i.e.* Rs. 4-8 at 6 annas a day.

*A *chatta* in the Pilibhit fuel trade is 24 ft. × 6 ft. × 5 ft. or 720 stacked cubic feet.

The ditch soon acquires an exceedingly hard well-burnt surface. Brick lining apart from being expensive and cumbersome renders it difficult to make the kiln air-proof. A brick-lined kiln, half of which was constructed above the ground level, cost Rs. 113. It refused to cool!

(*iii*) *Inlet flues.*—Two inlet flues F_1 and F_2, each 9 in. by 9 in. are built in bricks and mud mortar at one end of the kiln. About 70 bricks are required for both the flues. The flues are finished flush with the ground level. A piece of iron sheet cut out of an old kerosine tin or a flat Allahabad tile is used to cover the flues as desired for the regulation of air inlet.

(*iv*) *Exhausts.*—Four exhaust vents, E_1 to E_4, are made $1\frac{1}{2}$ ft. away from the edge of the kiln. They are let into the kiln at depths of 1, 2, 3 and 4 feet respectively. Thus, the exhaust E_4 brings up smoke from 4 feet below the ground level. Earthenware pots are used for closing exhausts, dry fine earth or mud plaster making them air-proof.

(*v*) *Iron sheets.*—Six sheets, each 7 feet long $2\frac{3}{4}$ feet broad, cover the ditch. This allows an overlap of 1 foot along the long sides 9 in. towards the flue end, 15 in. towards the firing end and 6 in. in between the sheets themselves. Each sheet has long wire handles for ease of handling when they are red hot. Wire, it may be noted, radiates heat so rapidly that it never gets unbearably hot.

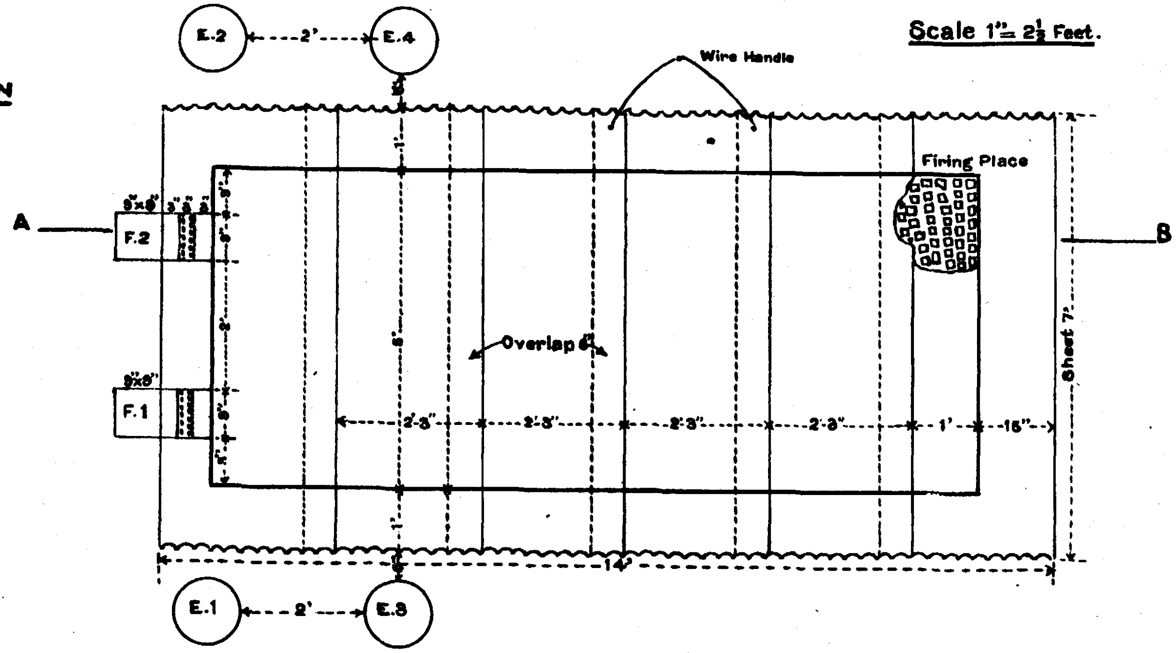
(*vi*) *Billets.*—Billets must be cut when the sap is down, air dried and preferably debarked. The smaller the wood the better the charcoal it yields. Big billets invariably remain unburnt at the core. Billets should be arranged parallel to the long side of the kiln to facilitate free inlet of air from the flues. As intense heat develops in the upper regions of the kiln, billets should be so arranged as to have the smallest at the bottom and biggest at the top. All sound miscellaneous hardwoods

PLATE 6A.

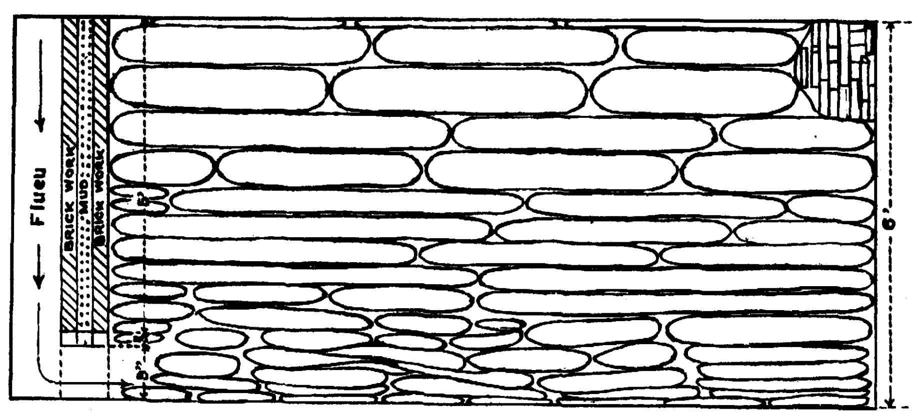
SKETCH SHOWING CHINESE CHARCOAL-KILN.

Scale 1" = 2½ Feet.

PLAN



SECTION ON A.B.



yield good charcoal. It is advisable to carbonise the same species at a time. A mixture of various hardwoods results in uneven burning.

(*vii*) *Firing.*—Dry wood twigs and grass are heaped up in a corner opposite the flue end and fired. As soon as this material catches fire well, iron sheets are placed covering the kiln from the firing end; the last sheet towards the flue end is placed in position after about 20 minutes when the fire catches green billets. If the fire is weak, all that is necessary is to lift for a while the last sheet at the flue end.

(*viii*) *Control of carbonisation.*—The fire draws the air through flues F_1 and F_2 under-ground. The smoke and flame travel along the upper layer of wood carbonising it gradually in a limited supply of air. Exhausts E_4 and E_3 are kept closed in the beginning. White dense clouds of smoke consisting of water vapour and other gases come out of E_1 and E_2. In about 12 hours or so the smoke turns bright blue and about 6 hours later becomes invisible layers of convection currents of intense heat. At this stage exhausts E_1 and E_2 are closed, E_1 later than E_2. Exhausts E_3 and E_4 are now opened and operated in the same way and closed after about 18 hours. Left without any exhaust, one of the two inlet flues now takes the role of an exhaust vent and begins to emit white smoke turning blue in about 12 hours. Depending upon the moisture content of the wood used, the species and weather conditions, the carbonisation is completed in 48 to 54 hours. Both flues are then securely rendered air-tight. The kiln cools in about 36 hours, when sheets are removed and charcoal is taken out. The kiln is then recharged and fired.

It might be noted that lifting the last sheet at the flue end removes smoke from the uppermost layer of the kiln, while exhausts E_1, E_2, E_3, E_4, negotiate with levels at 1, 2, 3 and 4 feet below the ground level. During

the very last stage one of the flues exhausts smoke from the ground level. Exhausts rather than inlets control the speed of carbonisation.

(*ix*) *Charcoal.*—While collecting charcoal, watch for any smouldering piece. It will set fire to the entire stack. Charcoal must be stocked in a clean dry place, preferably under thatch to protect it from wind and rain. The quality of charcoal produced is invariably excellent and answers to the specifications laid down for producer gas*.

(*x*) *Useful data: Jaman* (*Eugenia jambolana*).—In collaboration with Mr. Onkar Sahai, charcoal contractor, the following data was collected by Mr. Niranjan Lal, Forest Ranger, Mala:

(*a*) Time taken in carbonisation.
Average of 6 runs of 5 kilns ... 48 hours

(*b*) Time taken in cooling.
Average of 6 runs of 5 kilns ... 30 hours

(*c*) Yield of charcoal.
Average of 6 runs of 5 kilns ... 18 per cent.

The wood was green and freshly cut when the sap was up (May). The average yield of charcoal, is therefore, low.

Compared with the paraboloid kiln (*vide* Plate 6, Fig. II) commonly employed in the manufacture of charcoal in these provinces, the advantages of the Chinese kiln are:

(*i*) The Chinese kiln is simple to construct, easy to look after and does not require an expert *mistry* (operator) to watch its carbonisation. One man can look after a battery of five kilns. The paraboloid kiln is difficult

*Charcoal of good quality retains the grain of wood; it is jet black in colour with shining lustre in a fresh cross-section. It is sonorous with a metallic ring, and does not crush, nor does it soil the fingers. It floats on water, is bad conductor of heat and electricity and burns without flame. Its calorific value ranges between six and seven thousand calories. It readily absorbs moisture from the air, the normal moisture content being between 5 to 10 per cent.

to construct, often falls in course of first burning, requires constant attention, and leaks have to be mud-plastered all the time. Water is a very important factor in the selection of locality for a paraboloid kiln, a limitation not imposed by the Chinese kiln.

(*ii*) The Chinese kiln is portable in the extreme. Two bullock carts will carry the iron sheets, bricks and all of a battery of 5 kilns from site to site. The so-called portable 'Frikiln' designed at the Forest Research Institute, Dehra Dun, apart from being prohibitive in cost, weighs 32 maunds! The weight of 6 iron sheets used in the Chinese kiln is just over a maund. The Chinese kiln incidentally carbonises 60 per cent. more wood than "Frikiln" in one run.

(*iii*) The carbonisation is much more rapid in the Chinese kiln taking about 3½ days as against 8 days in a paraboloid kiln.

(*iv*) The loading and extraction of charcoal is naturally easier in an open ditch than in a covered paraboloid kiln.

(*v*) After reckoning the initial cost of 6 iron sheets it may be noted that the running costs are comparatively very much lower than those of a paraboloid kiln.

The Chemistry and Minor Forest Products Branch of the Forest Research Institute, Dehra Dun, comments as follows.—*Ed.*

The Chinese kiln described by the author is practically the same as the pit kiln used in Australia, with some modifications regarding smoke outlet.

The "Chinese kiln" is really a pit kiln and its capacity can easily be altered by changing the dimensions of the pit and therefore the statement that the "Chinese kiln" carbonises 60 per cent. more wood than the "Frikiln" relates to a certain size only.

Some information as to whether the yield figures are based on air-dry wood and charcoal or on the zero-moisture basis would be welcome. Figures of ash and volatiles content of charcoal made in the kiln may be given for comparison with charcoal made in other types of kiln. Readers would also be interested to know the cost of making charcoal in the kiln.

EXTRACTS

WHAT IS FORESTRY?

BY R. E. MCARDLE,

Appalachian Forest Experiment Station

Foresters need feel no particular embarrassment if they are unable with academic precision to compress a definition for forestry as a profession into half a dozen words. We have plenty of company among other professional groups. Within the past week I have asked a preacher for a one-sentence definition of religion, an economist for an equally concise definition of his work, and an outstanding engineer to define "engineering" in a dozen words of one syllable. Each man gave me the usual textbook statement,

paused momentarily, looked slightly confused, and then splurged full speed into a seemingly endless "explanation" of exceptions to the standard definition, and expansions of it. To me, this is indicative of a good, healthy condition and I hope the time never comes when foresters will stop asking themselves "What, exactly, is forestry?"—even if that question does sound foolish to the superficial. My own very strong conviction is that foresters will be like squirrels in a revolving cage when they decide, world without end, that the dividing line between forestry and other sciences (and arts) is exactly and precisely here and here and here. If that time comes, and it wouldn't matter to me how big the field might be, I'd feel like saying that forestry had joined the dead languages. Pardon the dogmatic phraseology but I hope you gather the general impression that if your group intends to say that forestry is precisely and exactly this and this and this, I am opposed to it.

My thesis is that I am perfectly willing to use the classic definition (which, as well as I remember, is to the effect that forestry is the business of growing and harvesting successive crops of timber on the same piece of land) as a starting point, but not as an ending point. I suspect that much of the argument revolves around the question of what a forester needs to know in order to grow and harvest crops of trees. One narrow interpretation I have heard would make a forester strictly a silviculturist knowing little more than regeneration and thinning. I have heard others enlarge at entirely unnecessary length on the business aspects. This particular group usually winds up with the entirely obvious conclusion that the best forestry is that which pays best and by "most profitable" they sooner or later restrict themselves to the better site qualities. Whereupon those who are also thinking of the other couple of hundred million acres of forest-covered land in this country get riled and leap into the argument. And so on. To get down to brass tacks, aren't you trying to determine if, in addition to basic instruction in regeneration and silviculture, forestry schools should teach such subjects as utilization, range management, and recreation? And if the answer is "yes" then how much of each shall be added to the basic formula for a professional education in forestry?

To those questions I don't believe there can be cut and dried answers that will hold for all parts of the country and for all time.

There are some subjects—call them phases of forestry or don't call them phases of forestry, as you please—which at present are taught only or chiefly in forestry schools. Wood utilization in all its aspects is such a subject. Range management, wild life management, and recreation are others. Until other colleges or schools begin to specialize in these subjects the forestry schools are the only places a student can turn to for instruction. In some places other divisions of universities are beginning to get into some of these field. For example, in range and pasture management. Some will say I am talking about specialization and I am, of course. You will note that I am not even arguing the suggestion certain to be made by some foresters that foresters should "stick to their knitting" and leave these specialized fields to other specialists. My point is that forestry schools are now the chief or only source of training for certain subjects such as those I have just named. I believe the forestry schools will need to continue instruction in such subjects.

It seems to me that the real question is how much of range management, recreation, watershed management, etc., the so-called drift forester silviculturize should know; and how much silviculture the range management, etc., men should know. I think this depends quite largely on what the student wants to do after graduation and for whom he is going to work. There was a time when only one bureau of the federal government offered employment opportunities. There was a time when most forestry students thought of forest research as the goal at which to direct their life work. (And a few forestry schools still haven't been jarred loose from this idea.) Now there are many different kinds of opportunities for employment. I won't go into details; you know them. These employers want the emphasis in education placed on different parts of the whole forestry curriculum, some on this part; others elsewhere. Call it specialization if you prefer. And please note that I include specialization in silviculture Anyway, it strikes me that the forestry schools have gotten themselves into considerable confusion by trying to turn out monkey wrenches, so to speak, that will fit all kinds of jobs. It just can't be done, even if we face the fact that considerable specialization ordinarily doesn't make a 4-year student very much of a specialist—he still has a lot to learn after

he goes on the job. So I think your problem is one determining the amount of adjustability you need to build into this specialized wrench.

To find out about this you will have to go to the future employers, somewhat as you are doing at this meeting and as some schools have been doing for several years. I am certainly not going to attempt to speak with authority for all classes of employers. I think, though, that all employers have certain wants in common. I think, also, that the things they want most are not necessarily the subjects taught in forestry schools or any other kinds of schools. My experience has been that we all want genuine ability, much more than we want exhaustive specialization in certain skills. What we want is ability to think, initiative, energy, and enthusiasm; a good personality, a co-operative attitude. Only in the research field—which is pretty small—is extensive specialization of top importance and my own feeling is that even in research I'd take intelligence in preference to trade-school training.

I could expand on that topic but there isn't much the forestry schools can do about it, anyway, until they reach the stage when they are willing or able legally to restrict enrolment and to raise standards generally by a number of devices already well known to them.

Moreover, what field of specialization the employers prefer I think most of us want our new employers to have at least some knowledge and appreciation of the whole broad field of forestry. The student need not be expert in silviculture if he is going to work on the treeless plains for the Grazing Service or in the laboratory of a paper company. But I think he should know the commercially important tree species and woods and have at least some idea of what is meant by silviculture. Conversely, the silviculturist who intends to seek employment with a lumber company need not become expert in landscape design or wild life management. To succeed here—at least at present—he needs to be a good surveyor and timber cruiser. I hope the time will come soon when the majority of the foresters in private employ can devote their time to silviculture. A few do now. When that time comes, they should have at least a background knowledge of range management,

erosion control, and so on. They can get plenty of free advice from experts if they know how to draw on the knowledge possessed by the experts. Still the largest field of employment is public agencies dealing with management of so-called "wild" lands, some of which actually may be very productive. I know a little about the needs here. Although it is true that specialists are required, it is also true that the majority of employees need an educational background covering forestry in the broadest possible meaning of that term.

I am, of course, simply giving you the old—and much-tossed around—argument for (1) early removal of dumb-bells, (2) a more comprehensive education—you make your own definition for "edution", and (3) specialization in varying degrees to fit different types of employment. I don't believe this can be done in four years. But the forestry schools can go a long way toward these objectives by requiring stiffer courses, a really full load of courses each semester, and specially by stopping this ever-lasting division and re-division of strictly forestry courses every time a new teacher is hired. My best insulting guess is that most of the strictly forestry courses now given in most schools could be compressed into half the time to gain opportunity for other subjects. Certainly there is no need, for example, for students to have to memorise three or four sets of figures on how much saw timber or pulpwood there is in the United States. Certainly there is no great need for forestry students to become artists and a good deal of drawing could be cut out. In short, I wouldn't cut down on the scope of forestry teaching but I would try to eliminate duplication and what might be called "busy work" which students do while the profs. pursue their researches or whatever it is that profs. (forestry and otherwise) do when they stay out of the class-room.

You will observe that in the course of this "tirade" or "searching analysis" (depending upon the point of view) I have only indirectly considered multiple use of forest land. I do so because I think it leads us astray from the real issue which is not what forestry teachers think forestry is but what prospective employers think it is—or rather, what they want in the way of employees. All employers have to consider the multiple use of forest land because even though one use may be dominant over large areas they can't

prevent other uses from happening whatever their preferences may be. For example, rain is going to fall on the timber production forest no matter what the owner thinks about stream-flow regulation. From the standpoint of the people at large he may in the not too distant future be required, in the public interest, at least to avoid doing certain things to that forest which produce harmful effects on stream-flow and soil losses. Likewise, the timber producer would have a hard time keeping wild game out of his woodlands and unless he knows a little something about wild life he may have quite a little trouble in getting the timber production he desires. And, in certain forest types he may want to graze cattle or sheep—or his neighbours may want to, which is worse. Such things as these are multiple uses of the same piece of land and the chances are that they will go on no matter what the land-owner prefers to have.

There is also another type of multiple use into which most landowners are forced for one reason or another. I suppose this might be called multiple use by individual areas within larger areas. For example in one ownership there are not only top-quality timber-producing areas but also patches, large and small, of poor land. Mostly, these less productive areas can't be eliminated so the wise owner looks about for other ways to use them than for timber production. For each individual area he has essentially single use, but for the area as a whole he has multiple use. Don't tell me this isn't the standard definition for multiple use. Call it what you please, this is what you get and any landowner who thinks he can avoid it either has only a few acres of land or else he just isn't facing the facts of life.

But—if I may offer the suggestion—I'd stay away from arguing what is multiple use. Instead, I'd think of the employer and what he wants. Whether or not the employer should be allowed to have what he wants is another subject, so for Heaven's sake, let's stop this thing.—*'Journal of Forestry,' Vol. 40, No. 2, dated February, 1942.*

IMPROVEMENT OF GRAZING GROUNDS IN ASSAM

By R. C. Woodford

Director of Agriculture, Assam

Grazing land is similar to all other land in that if it is desired to increase the production and improve the quality of grass, it is necessary to work on it. In Assam this work signifies clearing jungle, weeding, rough levelling, drainage of wet pockets, and finally top cultivation with top dressing or top manuring. Deep ploughing or hoeing of grazing land is usually followed by many years of heavy weed infestation, especially the giant Ageratum and is definitely to be avoided.

The need for clearing the jungle and weeding is obvious. If non-edible plants are replaced by grass, the production is increased. A few trees for shade should be left. This work should be done annually, preferably before the weeds form seed. Cutting is useless except for the annuals. Uprooting is necessary, and, if continued annually until the grass gets a good hold all over, there comes a time when the grass itself keeps the rest out. Rough levelling can be done along with top cultivation of which it is a part. Hummocks and mounds are cut and used to fill small depressions. If wet pockets exist an increase in grass, production can be obtained by draining them.

It is necessary to remove old roots, stubble, and that remaining from the previous monsoon season; this is done by annual burning in the dry season. The burning is done piece by piece so as not to remove all the remaining grass at the same time. Burning is not recommended everywhere; but in the grazing ground of Assam it is necessary. It destroys the eggs and larvae of the internal parasites or worms which are one of the main causes of the degeneration in our cattle (nature does this in other countries by means of frosts or excessive dry heat, but not in Assam). Burning in February-March removes the coarse, inedible stubble and stimulates new growth which also comes on earlier; it makes top cultivation easier.

The operation to follow burning is harrowing. Owing to the harder soil the peg-tooth and chain harrows used in other countries are not enough though they do some good. The disc harrow is

recommended, passing it two or three times, each time crossing the other. This is the time to do rough levelling. The harrowing also disperses and spreads dung droppings.

If the disc harrow is not available, still better results can be obtained by light sheel hoeing of grazing land. By this operation the breaking of roots, stubble and mat, aeration of the surface soil, stimulation of new growth, and the dispersion of dung droppings is very efficient. Rough levelling comes automatically at the same time. The time of year for this operation is February-March; it need not necessarily be done every year; once in two or three years would improve the grazing immensely.

Top dressing is best utilized if given before top cultivation which works it into the soil. Lime is good for grazing land, as it encourages leguminous plants of the clover types which have the highest food value, and makes the plant food stored in the soil available. Any quantity of lime up to 50 maunds an acre will do good.

Bone-meal at 3 to 6 maunds an acre is useful, lasting in effect, and cheap. But it must be sterilized. Unsterilized bone-meal is 8 annas a maund cheaper, but there is danger of introducing anthrax. Basic slag at 3 to 6 maunds an acre is perhaps the best manure for grass. Super-phosphate is also among the best. A New Zealand grazing farmer who wants to fatten his cattle does it by feeding the land with super-phosphates. Ammonium sulphate makes grass do a quick growth but in Assam we have plenty of coarse growth; what we want is 'bottom' and sweetness which is best obtained by lime and phosphoric acid. Finely powdered oil-cake at 10 maunds per acre upwards is very useful, but weeding may be necessary afterwards.

We are often asked what is the correct number of cattle to be allowed per acre of grazing. It is difficult to answer because land varies so much. In one way the answer is, the fewer the better, but there is a limit to that because the coarse growth must be kept down or it soon becomes inedible under our conditions. Counting all heads except suckling calves and allowing for our small cattle, three per acre is generally the limit and two per acre is better. One buffalo is reckoned to equal three cattle.

Three months' rest in the year will do grazing ground a lot of good. The figure is not put higher because under our conditions

more resting of the land in the monsoon would result in a coarse, inedible growth. Work on grazing land gives it a rest while the work goes on, and does it good that way also.

If it were proposed to plough, clean, manure, and cultivate grazing land into a new seed bed, and then re-sow it to a good grass mixture, there would be two difficulties. First, a grass seed mixture suitable to the country is not obtainable as no one produces it because hitherto there has been no demand for it and, secondly, it would have to be hand-weeded for some years; otherwise the new grass would be smothered, and that is expensive and troublesome.

The two most common grazing grasses in this province are known as *ulu* (*Imperata arundinacea*) and *bon-guti* (*Andropogon aciculatus*). The finer grasses, of which *dub* (*Cynodon dactylon*) is by far the best, cannot stand up against them unless the soil condition is improved and over-grazing is prevented. Under over-grazing conditions only grasses having the power to spread by an underground root can survive. But there are finer local grasses present everywhere and they will increase and spread under good management.

"Indian Farming," Vol. III, No. 8, dated August, 1942.

VOLUME LXIX 97 NUMBER 3

INDIAN FORESTER

MARCH, 1943

RELATION BETWEEN ROOTS AND METHOD OF IRRIGATION IN DRY TRACTS OF THE PUNJAB

By P. N. Deogun

Summary.—The note deals with: (*i*) a general description of the irrigated plantations of the Punjab, (*ii*) the development of irrigation system and its effect on growth of plantations, (*iii*) observations made on growth of *sissu* in relation to its root system, (*iv*) experiments carried out to help *sissu* to produce a deep root system, and (*v*) disadvantages of shallow irrigation and advantages of having deep-rooted crops.

Introductory.—The object of this article is to remove some of the misconceptions introduced through certain writings about the root system of *sissu* in the Irrigated Plantations of the Punjab and to show how trees can be made to send down their roots to deeper layers—to subsoil water—in dry tracts and the advantages accruing thereby.

Punjab Plantations.—There are eight irrigated plantations in the Punjab varying in planted area from a few hundred to several thousand acres.

The soil of these plantations is alluvial—pure sand to pure clay with different admixtures and depths. The average annual rainfall varies from 5 to 21 inches, but is generally below 10 inches. Spring level is at 10.47 ft. below ground level but generally below 23 ft. Temperature variation is great; highest in summer, goes to about 122° F and lowest in winter to about 22° F under shade in certain localities.

It is clear that without irrigation water it is not possible to have these plantations in the dry tracts of the Punjab. Canal water for plantations is available from 1st April to 15th October, but even for this period the supply is not guaranteed. In the Sutlej Valley Project Canals regular supply does not begin before 1st of July and ends by middle of September.

Methods of Irrigation.—The first irrigated plantation, *viz*. Chhanga Manga, was started in 1866 with *flood* irrigation, it being the simplest and generally adopted by cultivators from times immemorial. This, with certain modifications, is still in vogue there.

An advance was made by reducing the size of irrigation plots and in younger plantations (started after 1913) irrigation through 12 inches deep trenches was introduced.

This was done for even distribution and control of water, and for helping germination of seed without any consideration to the development of root system.

In 1928 both the *flood* and *deep-trench* irrigation methods were condemned and one of *shallow and repeated* irrigation through 6 inches deep trenches was introduced as a measure of water economy in a number of plantations. *This new method permitted filling up of 6 inches deep trenches to wet the soil up to 4-5 ft. depth and no more after short intervals* as compared to the *old deep one of flooding* or *filling to overflowing 12 inches deep trenches after long intervals*. This new method originated in Montgomery Division and was considered to be very economical. It is described in the *Irrigated Plantations in the Punjab*, Chap. X, by Bahadur Singh, and is mentioned in the *Manual of Indian Silviculture*, pages 238-239, by Champion and Trevor.

This was not introduced in Chhanga Manga and only partially in other divisions. Under this method the subsoil water was considered far beyond the reach of *sissu*—wrongly characterized with a shallow-root system. In the words of its originator:

> ". . . In the case of *shisham* (*sissu*) grown in plantations the active root system extends only 4 feet below ground level . . . ." (*Indian Forester*, page 457, July, 1935).

This method lasted for about 10 years. It was given up in the beginning of 1939 on a representation by the writer as it was not found conducive to proper growth of trees and one of *deep irrigation* or *addition of sufficient water at a time, through trenches to wet the soil right down to the subsoil water* was adopted.

Under the "shallow and repeated" method of irrigation large areas dried up or became very poor and victims of several calamities. In the three plantations of Montgomery Division—the home of the

PLATE 7.

ROOT SYSTEM OF SHISHAM (DALBERGIA SISOO)

i & ii FROM DEAD AREAS IN DIPALPUR iii, FROM A HIGH AREA IN CHICHAWATNI

Scale 1" = 2 ft.

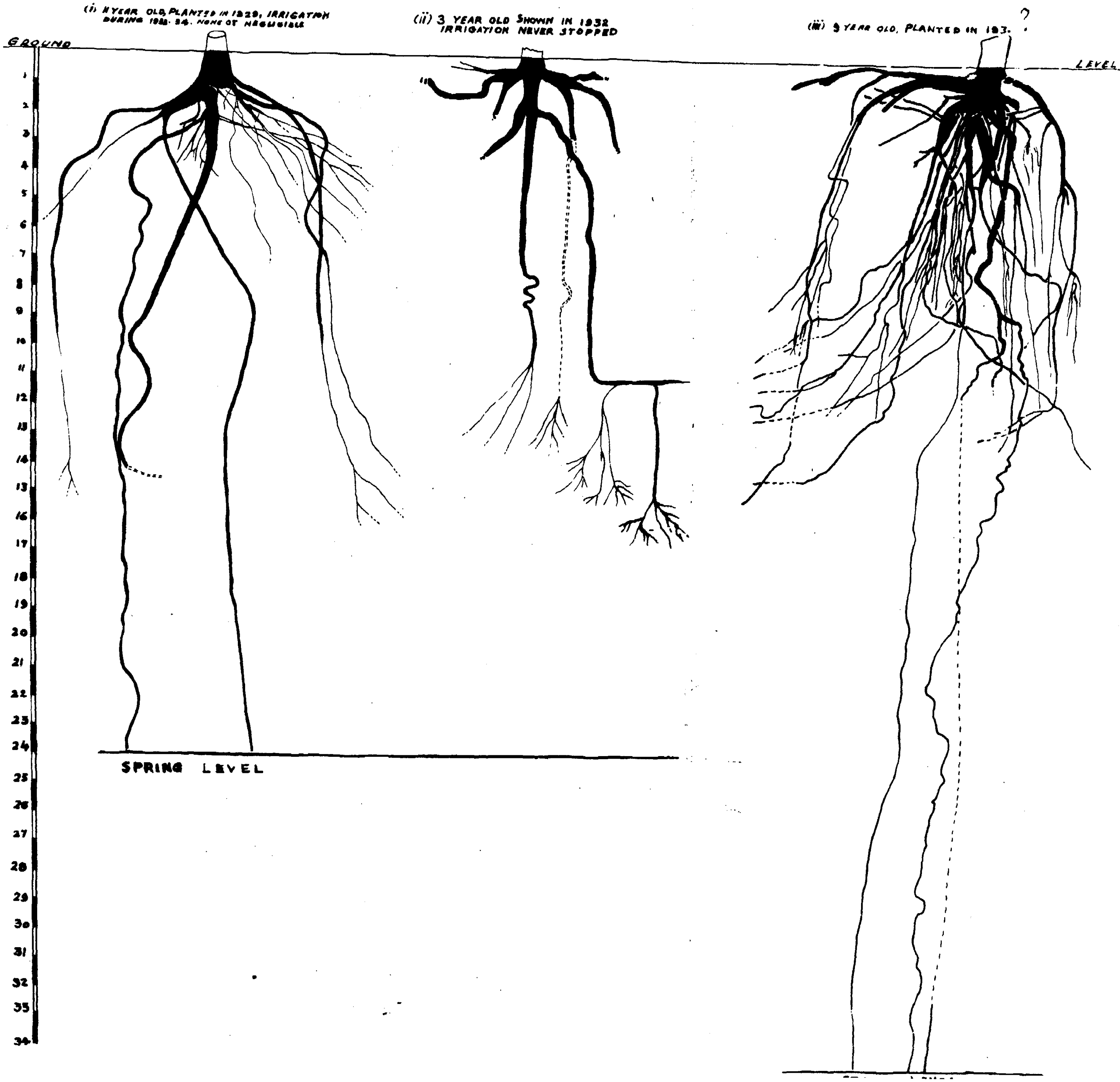
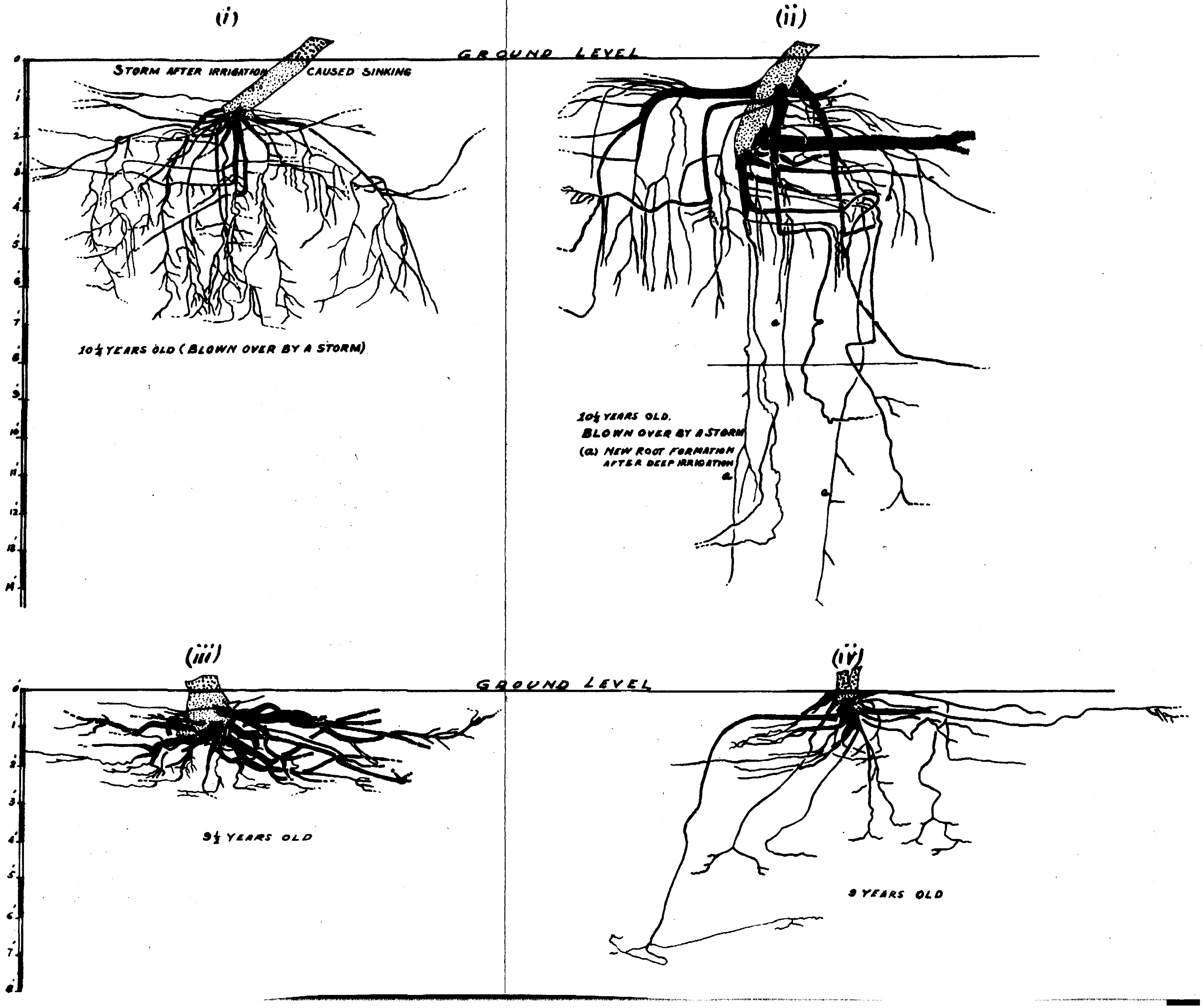


PLATE 8.

ROOT SYSTEM OF Shisham (DALBERGIA SISSOO)

GROWN UNDER SHALLOW & REPEATED IRRIGATION

SCALE 1" = 2 FT.



new method—stock-mapping showed 22, 19 and 18 per cent. area with normal and 61, 42 and 34 per cent. with dead or dying crop.

Observations and Experiments.—Some planted areas were abandoned as failures. Efforts to restock these were unsuccessful. In such areas, in Dipalpur plantation, with spring level at 24 ft. a number of trees scattered as well as in groups, remnants of original stocking, were found to be growing in spite of the stoppage of irrigation.

Growth of a number of such trees was studied through stump analysis. A number of pits were dug; soil and root system of some were examined.

It was found that roots of trees in good health and growing more or less normally were strong, fat and extended down to subsoil water, but those of poor health were poorly developed with a number of bends and constrictions, deep but not down to spring level (*see Plate 7, Figs. i and ii*).

Diameter increment put on by healthy trees was found to be more or less independent of the "shallow and repeated" irrigation given during irrigation years. This showed that such irrigation never penetrated to a depth where it could be of help to these plants and that the trees mostly depended on subsoil moisture.

This growth was compared with trees of the same age in the adjoining areas which were never starved but kept under shallow irrigation. Trees from the starved areas showed slightly better growth. This, most probably, was due to the fact that trees in the starved areas had their roots in the subsoil water and were not affected by the atmospheric changes, causing a setback, which they had to surmount before progressing further.

More pits were dug in different places in all the three plantations and roots of plants studied and sketched. A rough study of the soil and presence of moisture was also made.

It was found that in areas kept under shallow irrigation *sissu* roots remained shallow (*see Plate 8, Figs. i—iv and Plate 9, Fig. i*). Their downward penetration was independent of age and by no means confined to within 4 feet of ground level as recorded in the *Indian Forester*, July 1935, pages 455 and 457, or on pages 53 and 54 and shown in Fig. 10 of the *Irrigated Plantations of the Punjab.*

In these shallow-rooted trees there was no root extending to the water table (*see Plate 8, Figs. i—iv*). Roots of trees in areas which got enough water at a time to soak down to the lower depths, though after long intervals, penetrated to lower regions of subsoil water in various numbers and in various formations but in no case as a single tap root (*see Pate 7, Fig. iii*).

Penetration of moisture after irrigation through pits and trenches and after rainfall was also studied.

Production of Deep Roots by Sissu.—Experiments were conducted during 1939 to 1940, to force *sissu* to develop a deep root system. To achieve this, deep and controlled irrigation through trenches and pits connected by trenches was given. The object was attained. Further experiments were conducted to cut down the number of irrigations and increasing the interval between them.

Large number of pits were dug and roots of plants studied and sketched, some of which are shown in *Plate 10, Figs. i—iii* and *Plate 11, Figs. i—iv*. In every case it was found that deep and controlled irrigation resulted in roots going down to sub-soil water.

It will not be out of place to mention that most of these pits with roots were inspected by the Hon'ble Minister for Development, the Financial Commissioner, the Chief Conservator, Conservator, Western Circle, and several other officers. Sir Harold Glover, the Chief Conservator of Forests remarked:

"The Divisional Forest Officer, Mr. P. N. Deogun, is convinced that shallow irrigation as practised in the past was wrong and in order to confirm this he has dug up numerous plants to examine their root systems. Where repeated shallow irrigations were given the roots spread near ground level where few deep irrigations were given the soil is moist for many feet down and the roots have followed the moisture often until near the subsoil water. One 9-month-old shisham plant of height 6 feet had roots down to below 16 feet. The results of these tests are remarkable and to my mind are conclusive. Four to six deep irrigations per annum are better than the numerous shallow irrigations given in the past."

In one set it was found that stumps planted on the berms of pits 1 ft. × 1 ft. × 1 ft. (deepened to 15 inches after 2 months), connected by shallow (5—6 inches deep) trenches sent their roots down to 8 ft. and 16 ft. after 3 and 8 months as compared to 6 ft. and 12 ft. by those on the berms of trenches $\frac{12+8}{2} \times 9$ in. (*see Plate 11, Figs. i—iv*).

Fig. I

Photo: P. N. Deogun.

Dipalpur Plantation

Result of shallow and repeated irrigation ($10\frac{1}{2}$-year old *sissu*)

Fig. II

Photo: P. N. Deogun.

Chichawatni Plantation

Cpt. 138. Result of a storm after irrigation of a shallow-rooted crop ($12\frac{1}{2}$-year old *sissu*)

Interval between Irrigations.—One-year-old plants grown with deep roots were treated in randomised plots differently as regards interval between two irrigations, given through pits 18 inches deep, dug alongside the plants. In one set of plots three irrigations, *i.e.* on 4th April, 6th August and 11th October, and in the other set five irrigations, *i.e.* on 4th April, 25th May, 12th July, 28th August and 11th October, were given. At the end of the year no difference between the growth of plants of the two sets was discernible. The weather was not bad as it can be in these parts, the total rainfall between 4th April and 7th August being 3.6 inches. It was a great thing to know that even one-year-old plants, with deep roots, could stand an interval of 4 months between the first and the second irrigation. Giving of first irrigation in the beginning of the season and of an intensity to join on to the subsoil water is important.

Depth of Root Activity.—An examination of the soil before the second irrigation in the case of the above-mentioned plots showed that the top 4 ft. of soil was dry and yet the plants were healthy and growing.

In another area with a two-year-old crop the first irrigation of the season was given on the 7th May. After two months when the soil was examined the top 7 ft. was practically dry without the plants showing any sign of ill-health but they were healthy and growing.

The plant examined had its roots more than 25 ft. deep on within 4-5 ft. of spring level. The small roots in the upper dry layers were found with thin layers of moist earth round them.

It was also found, by actual practice, that rejuvenation of poor and young crops which had not lost their crowns, or were not badly damaged was possible by a change in the methods of irrigation from one of 'shallow and repeated' to that of 'deep and controlled'. Younger crops responded within a year's time by producing new leaders and deep roots (*see Plate 10, Figs. iv and v*). The response in older crops which had been badly damaged through improper irrigation was not so marked. Crops that had been badly damaged, half-dead, died back, etc., were rejuvenated by coppicing and irrigating properly.

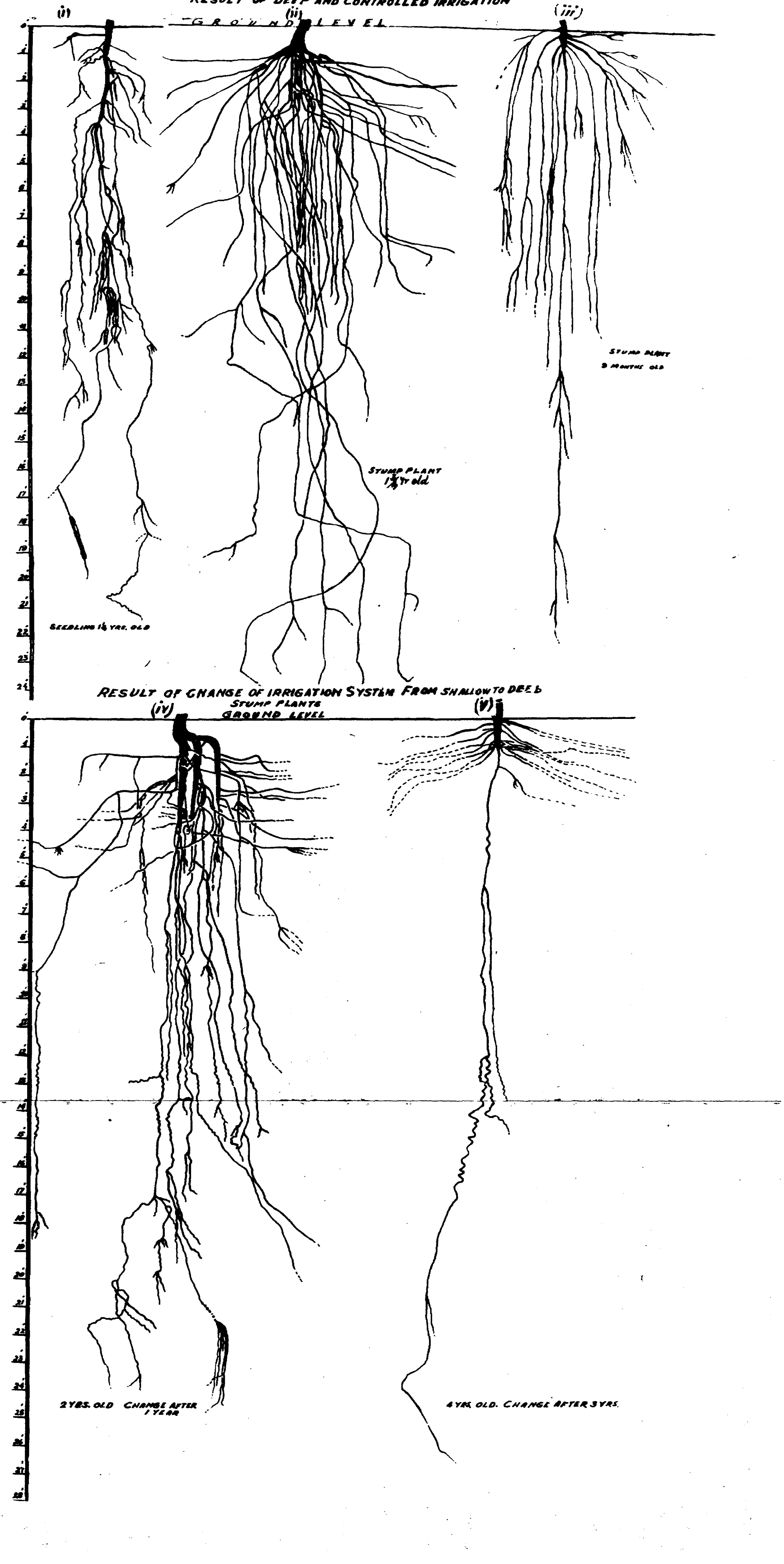
Table top critics can ask hundred and one questions. The reply to all is one and simple. Experiments were conducted to find out if *sissu* can be made to send down its roots to the subsoil water and help itself with the same at an early age. It was found that *sissu* can send down its roots to subsoil water in a few months if properly irrigated and that it helps itself from the subsoil water. Details can be seen in *How to Grow Shisham* by the author.

Results of the work done were contrary to those recorded in the *Irrigated Plantations in the Punjab* which has been the standard book for plantation officers so far. It was found that in the dry tracts of the Punjab under irrigation, on an average soil, *sissu* has no single tap root but a number of roots which replace the original tap root of a seedling plant; that the most important factor controlling the development of root system is the method of irrigation, not considered as such so far; that the shallow system ascribed to *sissu* is not its characteristic but the result of shallow irrigation, that there is little relation between its age and depth of roots; that under a system of irrigation which does not permit the wetting of dry layers of soil below the growing roots or which permits of better moisture conditions in the upper layers of soil constantly its roots tend to become superficial; that the subsoil moisture and water is not beyond its reach, but can be made available by proper technique of planting and irrigation; that it can be made to send down its roots to subsoil water in less than one year; that its sphere of root action is not confined to 1—4 ft. below ground level but right down to subsoil water and that a deep-rooted *sissu* is far superior to a shallow-rooted one.

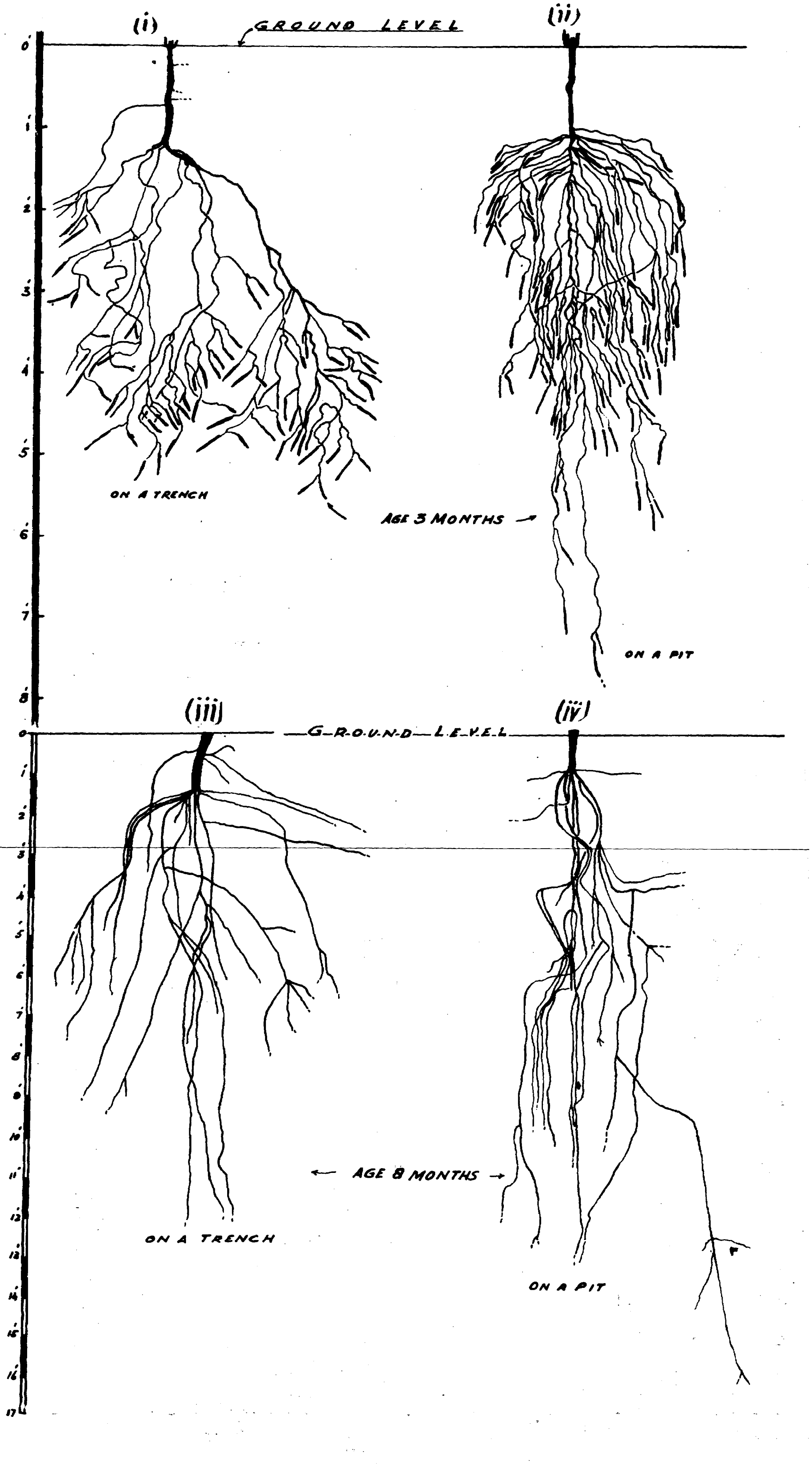
How it works.—What actually happens is very simple and can be understood easily by visualizing the condition of soil in the field with respect to the moisture content, in a vertical column, in the dry tracts, with low spring level. For this it is necessary to have some terms explaining the condition of mixture. Veihmeyer[1] has shown that when the soil is irrigated it is raised to 'field capacity' moisture content to a depth for which the water supply is sufficient. Dr. Mckenzie Taylor[2] defines 'field capacity' as the maximum moisture content to which the soil can be wetted under the action of gravity in the field. Moisture stage lower than the field capacity

ROOT SYSTEM OF Shisham (DALBERGIA SISSOO) GROWN ON TRENCHES **PLATE 10.**

RESULT OF DEEP AND CONTROLLED IRRIGATION



ROOT SYSTEM OF Shisham (DALBERGIA SISSOO) PLATE 11.
GROWN UNDER DEEP & CONTROLLED IRRIGATION
STUMP PLANTS



stage is classified by him as 'pellicular stage' and the one higher than the field capacity stage as 'capillary stage,' but when the pores are completely full of water and the water is free as a body to take part in movements due to gravity the moisture conditions are termed 'the water-table stage'.

At a certain depth below ground level, which varies with different localities, is the spring level and the soil there is in water-table stage. Above this up to 2 ft. or 4 ft. of soil is in a capillary stage (Dr. McKenzie Taylor[3] and Keen[4]). Above this a certain depth of soil is in a field capacity stage and the rest up to the ground level in a pellicular stage.

Evaporation is the controlling factor in deciding the depth of pellicular stage zone. According to experiments carried out by Keen[5] this effect of atmosphere does not extend beyond 6 ft. from the ground level under the climatic conditions in England. It may be less according to the working of Afzal and Vaidhianathan[6]. In the Punjab Dr. Mckenzie Taylor[7] found it to extend to 8 ft., the more usual being 6 ft. under field irrigation conditions and down to 12 ft. in areas which had never been irrigated and had a low spring level (22 ft.).

Pits dug in areas which had been under shallow irrigation for some months before the digging, in the three plantations of Montgomery Division, showed a moisture line between 13—15 ft. below ground level, irrespective of the spring level which varied from 24—45 ft.

From the above it will be clear that in the dry tracts of the Punjab, with a low spring level, there is a distinct depth of soil whose moisture content is below the field-capacity stage and which can take in more water.

Different species have different powers of extracting water from the soil. Some of the soil in the pellicular stage zone is such as cannot part with any moisture for the use of *sissu*. Such soil will be termed 'dry' for the purposes of this article.

Before *sissu* roots can be expected to cross this dry zone, water has got to be added to it and a condition of soil produced to enable

the roots to draw their supplies easily from below. This condition has got to be kept up below the growing roots. It must be remembered that the roots have an eye for moisture, they take the line of least resistance and will not travel from a moist to a dry layer of soil.

Under irrigation conditions, Veihmeyer[8] has shown that water applied to the soil surface moistens the soil to field capacity to a depth for which the water supplied is sufficient and no more, so that if the quantity of water applied is such as will leave a dry layer below the growing roots—in between the wetted layers and the field capacity zone—the roots will not, by any chance, cross this dry layer. It is wrong to think that it is the age of the trees that makes them send down their roots to subsoil water (Bahadur Singh[9]).

Once the roots are guided across the dry layers to those which can impart their moisture easily, they continue their growth downwards by exhausting the upper layers and eventually reach the capillary zone from where they can draw inexhaustible supplies.

Addition of sufficient water to bring the soil from top to bottom in a field capacity stage is not sufficient to ensure a deep-root system. The interval between two such additions of water has to be considered. If it is shortened to such an extent as to keep the upper layers constantly in a field capacity stage, *sissu* roots, as is natural to them, will tend to spread more near the surface than downwards. This is the case along river banks and water courses. The interval between two waterings should be such as to allow some drying up of the upper layers of soil to force the roots to grow downwards, from drier to moister layers till the field-capacity zone is reached.

Once the *sissu* has sent down its roots to the capillary zone it will help the tree to pump up water without exhausting the source of supply, but from what depths and to what heights it can supply this water is yet to be studied. Roots working in the intervening layers will exhaust them of the moisture present therein unless the same is replaced by additions from the top. If the future additions of water are such as to leave a dry zone below, the natural tendency for the tree would be either to revert to a shallow-root system or to develop one in addition to the deeper depending upon its size, etc.,

and the additions of water. It is clear that future additions of water should be at sufficient intervals and such as to bring the whole soil from top to bottom in a field capacity stage. There is no doubt that the lower roots can supply a certain quantity of water to the upper roots, but to what extent, has yet to be experimented in cases of *sissu*.

Shallow Irrigation and its Disadvantages.—The basis of shallow irrigation as discussed by S. S. S. Bahadur Singh in the *Irrigated Plantations in the Punjab* and in the *Indian Forester* for July, 1935, under *Theory of Irrigation as Applicable to the Punjab* was shallow rootedness of *sissu*. The cause was taken to be the effect.

Shallow irrigation in an ordinary as well as in a hard soil produces shallow-rooted trees which are susceptible to changes in the atmosphere—to drought, frost, storms, etc. Such trees are solely dependent on irrigation water (or rain) and take no advantage from the subsoil moisture and water. Their growth period is guided by the availability of canal water at different times and in different quantities and by the weather conditions. Later leafing due to late watering, which is bound to happen over large areas, helps the *sissu* leaf defoliator (*Plecoptesic reflexa*) and other harmful insects. This leaf defoliator by keeping the trees leafless during the best part of the year reduces the growing period very much. Root competition between neighbouring plants and weeds is great. Total area tapped by tree roots is much smaller than what it can be. 'Shallow and repeated' irrigation helps superficial feeders like grasses so that *dab* (*Eragrotis cynosuroides*) and *Imperata*, get a good chance to spread, to the great disadvantage of trees and the inspecting officers who have to risk a cobra at every step. Loss of water through evaporation is directly proportional to the number of irrigations so that the total quantity lost per season is high and water is a valuable article. Irrigation costs are high, future crops suffer due to deterioration of soil.

All these result in failures or in the production of a smaller yield and a poorer quality of wood at a higher cost.

Conclusion.—If proper methods are followed *sissu* can be made to send down its roots to subsoil water in about a year's time. There is no doubt that *sissu* with its roots in the capillary zone can help

itself from the subsoil water. Whether it can be independent of the superficial irrigation and put on normal growth, in the dry tracts of the Punjab, with a poor rainfall, is yet to be studied. There is no doubt that in places where the spring level is high, say within 8 or 10 ft. of the ground level, once it has got established with a strong root system, it can continue to grow without any superficial irrigation. In places with a low spring level it may live for some years but its putting on normal growth without superficial irrigation is not certain and rather doubtful. Individual trees, after they had got established, have been seen growing without any irrigation, for some years past, in areas with spring level as low as 30 ft. One thing is certain; *sissu* with deep roots can stand long intervals between irrigation and this fact alone is going to be of tremendous help to the planter in the country.

It is up to the whole-time experimenter to find out the actual depth of water to be delivered and how. This is bound to vary with different localities, soils, climatic and weather conditions, species, ages of plants, etc. A start can be made at Chichawatni with *sissu* crop established during the last three years with deep roots (*see plate 12*). The experiment will require the help of a soil expert and his laboratory. Actual quantities of water required to keep the soil in a field capacity stage below a certain depth can be worked out by watching the condition of foliage, growth of new shoots and by taking soil samples and determining their moisture content, etc.

Help given by the subordinates especially by M. Bhawani Singh, Forest Ranger, and Mohd. Iqbal, Forest Guard, in making observations and conducting the experiments is gratefully acknowledged.

LIST OF REFERENCES

[1] F. J. Veihmeyer	.. "Evaporation from Soils and Transpiration," *Trans. Amer. Geoph. Union (19th Annual Meeting), 1938, pt. II, p 613.*
[2] E. Mckenzie Taylor	.. "Some Aspects of the Physics of Water Table Rice and Salt Movement in the Soil under Irrigated Conditions.
[3] Ditto	.. *Loc. Cit.*
[4] B. A. Keen	.. "What Happens to the Rain?" *Quar. Jour. Roy. Met. Soc., London, 1939, 65, 134.*
[5] Ditto	.. "Soil Physics in Relation to Meteorology," *G. J. Symon Memorial Lecture, Roy. Met. Soc., London, 1932.*
[6] M. Afzal and V. I. Vaidhianathan	"A Note on Capillarity and Sub-soil Water Table," *Proc. Ind. Acad. Sci., 1939, 10, 309-10.*
[7] E. Mckenzie Taylor	.. *Loc. Cit.*
[8] F. J. Veihmeyer	.. *Loc. Cit.*
[9] S. S. S. Bahadur Singh	.. *Irrigated Plantations in the Punjab*, pp. 41, 42, 53 and 54.
[10] H. G. Champion and Sir Jerold Trevor.	*Manual of Indian Silviculture*, pp. 60, 61, 238 and 239.
[11] P. N. Deogun	.. *How to Grow Shisham*, p. 10.

CHICHAWATNI PLANTATION

Fig. I

Cpt. 232. *Sissu* one season old

Fig. II

Cpt. 227. *Sissu* three seasons old after first thinnings

VALUATION SURVEY BY "SPOT METHOD"

BY K. KRISHNASWAMY

In the field season of 1936-37, the writer, while preparing a working plan for the forests of Bhadravati Division, was faced with the task of completing the valuation survey of about 120 square miles of forest in a relatively short time and with limited staff. Till late in February, 1937, one of the rangers posted for working plan duty had not joined, and the work in Aramballi State Forest had not even been started. The writer was, therefore, obliged to deviate from the time-honoured, relatively slow, method of valuation survey by linear diagonal strips and devise a rapid, yet reliable, method of carrying out the work allotted. The "Spot Method" was then conceived and put into practice for the first time.

It was, however, soon found and proved to the satisfaction of the Chief Conservator by means of test wholesale enumerations that this method is not only about twice as rapid as the "Stripline Method", but also more accurate and simple in field practice. Consequently, the Chief Conservator permitted its extension to Lakkavalli Forest and, in the following season, to Karadibetta State Forest. Since then, the method is being more or less widely practised in the mixed deciduous forests of Mysore.

The following is a brief description of the practical details of the method:

(1) *Personnel Required*:

(*i*) One specially trained forester or enumerator with experience of the work.

(*ii*) Three or four coolies.

(2) *Tools and Instruments*:

(*i*) One Gunter's chain or a metallic tape.

(*ii*) One light pole with a white rag tied to the top.

(*iii*) Three bill-hooks or axes.

(*iv*) Two or three callipers.

(*v*) One note-book for recording trees.

(*vi*) One drawing-board with pins.

(*vii*) A tracing of the area and a 'grid' with squares of the required size, depending upon the distance between the centre of one spot and another.

(*viii*) Pencil and a pair of dividers.

The method consists essentially in the enumeration of the growing stock in small circular areas—spots—of any convenient size, usually one chain (Gunter's chain = 66 feet) in radius distributed as uniformly as possible over a given forest. The number of spots in any given area of forest and their espacement will depend upon the percentage of partial enumeration fixed.

The following table shows the above figures calculated for different percentages of enumeration:

(1) Radius of each spot (r) = 1 Gunter's chain (22 yards).

Unit of area.	*Percentage of numeration.*	*Number of spots.*	*Distance from centre to centre of spots.*
	"P"	"N"	"D"
1 Square mile ..	10 ..	204 ..	123 feet.
	20 ..	407 ..	87 ,,
	30 ..	611 ..	71 ,,
	40 ..	814 ..	62 ,,
	50 ..	1,018 ..	55 ,,
(2) Radius of each spot (r) = 2 Gunter's chains (44 yards).			
	10 ..	51 ..	247 feet.
	20 ..	102 ..	174 ,,
	30 ..	153 ..	142 ,,
	40 ..	204 ..	123 ,,
	50 ..	255 ..	110 ,,
(3) Radius of each spot (r) = ½ Gunter's chain (11 yards).			
	10 ..	815 ..	62 feet
	20 ..	1,629 ..	44 ,,
	30 ..	2,444 ..	36 ,,
	40 ..	3,258 ..	31 ,,
	50 ..	4,072 ..	28 ,,

The above figures are calculated by the following formulæ:

(I) a=area of a spot:—πr^2

Where $\pi = \frac{22}{7}$; r = radius of each spot.

(II) If 'N' be number of spots in a compartment for a given percentage of enumeration 'P',

$N = \frac{L \times B}{p \times a}$ where L = length of the compartment under enumeration. B = width of the compartment under enumeration.

(III) If d = distance between one spot and another, *i.e.*, $\sqrt{l \times b}$ where l = distance from the centre of one spot to the next and b = distance between successive rows of spots, then, because the spots are distributed in squares, l = b = d, and $d^2 = \frac{L \times B}{N}$ or $d = \sqrt{\frac{L \times B}{N}}$; or, where L × B is represented by 'A' *i.e.* area of the compartment, $d = \sqrt{\frac{A}{N}}$;

In applying this method in practice the enumerator first goes over the area with map in hand and acquaints himself with the general nature of the country. A primary bearing, preferably the shortest direction through the area to be enumerated, and a straight base line is selected during this preliminary wandering. The enumerator keeps on his course through the forest by continually guiding the advance coolie carrying a pole along the primary bearing with a prismatic compass. *This coolie should carry a bill-book to* clear the line of sight. The distance between the centre of one spot and another having been calculated, the centre-point of each spot is determined usually by the enumerator. A tree, standing nearest to this centre-point, will be chosen, a ring of tar placed round it at chest height and the serial number of the spot is written upon it on the side *opposite to the direction of progress.* This tree is usually referred to as "spot-tree". A circle is aligned from the centre of the spot and of the required radius, say one chain, by means of a thin rope and all trees enclosed by the circle are callipered and entered in the enumeration register. The actual position of the enumerator at any moment is known by means of a chain or a tape held between the forward coolie and another, and by referring to a tracing of the area superimposed on the "grid". On reaching the

opposite boundary the enumerator measures a distance equal to that between the centre of any two spots at right angles to his original bearing, marks this point on the ground, retraverses the area on the back compass bearing, and checks his position on emerging on the base line back to the starting point. The whole area is, in this manner, traversed at regular intervals.

While carrying out this work the enumerator will ordinarily be able to note what the forest is like between the rows of spots. He will thus be able to stock-map the whole area. *Enumeration and stock-mapping can thus be done simultaneously.* The stocking can be conveniently noted on the tracing by letters.

Enumeration by this method was found in practice to have several advantages over the 'diagonal strip' method. They are:

(1) *It is cheaper,* because cutting of strip-lines which involves much labour is totally eliminated. The relative cost figures, worked out while enumerating Aramballi State Forest in Bhadravati Division during 1937 are given below:

State Forest.	*Area enumerated (acres)**	*Enumeration per cent.*	*Total Cost.*	*Cost per acre.*	*Method employed.*
			Rs. a. p.	Rs. a. p.	
Lakkavalli and Nandigave ..	3,358	20	1,760 10 0	0 8 5	Strip method.
Muthodi ..	2,369	10	1,329 11 0	0 9 0	Strip method.
Aramballi ..	1,432	20	451 0 0	0 5 0	Spot method.

*Area actually covered by the valuation survey party.

(2) *It is more rapid,* because no time is spent on cutting strip lines through the forest. This operation takes considerable time, up to about one-half the total time spent on enumeration. A party of five coolies generally cuts 50 to 70 Gunter's chain-lengths of line in a day in our bamboo forests. An enumeration party of six men, consisting of one enumerator and 5 callipermen, can enumerate about a mile-length of line $2\frac{1}{2}$ chains wide (20 acres) a day. Four or five men working by the spot method can do, on an average, 76 spots (of 1 chain radius), *i.e.* 24 acres per day.

(3) The valuation is simpler and more accurate, because human errors arising out of incorrect hearing or ignorance of species, especially while working with non-local labour, can be eliminated. The recorder will be able, in most cases, to see the trees he records. The spots being generally of one chain radius, the maximum distance he has to see or hear is 66 feet. Where forest undergrowth is dense, the size of the spots could be suitably reduced, making it easier for the recorder to see.

(4) For a given percentage of enumeration the spot method gives more accurate data because the spots lie essentially in squares and are uniformly distributed over the whole forest. They can convey, therefore, a more correct picture of the stocking. Diagonal strip lines usually run from corner to corner of a compartment, cross each other in the middle and thus miss the major portion of the vegetation which they are supposed to represent. This is the principal advantage of the spots over the strips. The spot method is therefore, more suitable for uneven-aged, irregular forests in which the condition of the growing stock, not infrequently, varies within a few yards.

(5) The smaller the size of the spots, within reason, the more uniform is the distribution of the area measured by callipers over the whole forest and, consequently the more correct are the valuation figures likely to be compared with the diagonal strip system.

(6) Stock-mapping is rendered easy and accurate owing to the need for a complete examination of the forest entailed by this method. In fact, stock-mapping and valuation survey can be conducted in one operation.

(7) Test checking the enumeration figures by the working plan officer can be done more conveniently and piecemeal, as the results of valuation of each spot can be recorded separately.

The following sample form will be found convenient for recording the figures gathered by the spot method:

Species...........Teak (or whatever) *Compartment No*.........

	Diameter Classes.						
Serial number of spot ..	I	II	III	IV	V	VI	
Spot tree No. 1							
Spot tree No. 2							
etc.							

Disadvantages of the Method:

The chief disadvantage is the large number of marginal trees, whose incorrect inclusion or omission would hamper the accuracy of valuation figures. Another, less important, disadvantage is that, if the results of enumerating each spot be recorded separately, the enumeration registers will become more voluminous than by 'strip method'. It is also difficult to apply the method in a forest with heavy undergrowth which impedes movement through it.

ARTIFICIAL REGENERATION OF *BABUL (ACACIA ARABICA)* IN SIND

By B. B. Wadhwani

Range Forest Officer, Jherruck (Sind)

Sind is a desert tract of land which knows no monsoon. The average annual rainfall is only 5—6 inches. But for the river Indus it would be impossible for any life to thrive here.

Irrigation of Sind is provided by the annual floods of the river Indus which occur between April and November, reaching their peak-level by mid-August. This period is termed *abkalani* and synchronises with melting of the snows in the Himalayas. It is during this season that all vegetation in Sind receives irrigation and this is the chief agricultural season of Sind. Sind forests too are, naturally, irrigated during this season. The exception, however, is the Sukkur Barrage zone which is in receipt of perennial supply of canal irrigation.

The Indus thus being the sole source of lifeblood of Sind, it is not surprising that a good portion of its population worship this *Sindhu* (Indus) and propitiate it with offerings of grain, sweets fruits, coins and other ceremonies.

Seed-collection.—Troup in his *Silviculture of Indian Trees*: volume II, page 427, states as under:

> "The pods (*babul*) are readily eaten by sheep, goats, and cattle, and the seeds are ejected by them. As far as recorded observations go the seed, (although it does so in the case of bovine animals), seldom passes completely

through sheep and goats, but is ejected by them from the mouth during rumination. The seeds are, it is true, found among their droppings, but this is because of the fact that rumination ordinarily takes place where the animals are herded. The fermentation and moistening which the seeds undergo before their ejection undoubtedly assists germination, and seed which has been ejected by animals is also held to be less liable to insect attacks than seed collected straight from the pod. The superiority of seed collected from goat and sheep pens is generally recognized, and seed so collected is extensively used for atrificial sowings."

Careful observations have, however, shown that even in the case of goats and sheep seed does pass through their bodies, undigested, as in the case of bovine animals. During seeding season, May-June, if an examination is made of the goat and sheep droppings thrown out by these animals, invariably a grain or two of *babul* seed will be found embedded therein. That is to say that the seed collected from the goat and sheep pens is both that ejected from the mouth during rumination and that passed through the digestive system, embedded in the droppings.

This method of seed collection is not only more convenient and economical, but, as stated above, germinates earlier and gives a higher percentage of success than that collected direct from the pod.

Artificial Reproduction.—This is divided in three classes, *viz*:

(*i*) Pre-*abkalani* sowings;

(*ii*) *Abkalani* sowings; and

(*iii*) Post-*abkalani* sowings.

according as the sowing operations are carried out:

(*i*) Before River inundation;

(*ii*) While the flood water is still standing on the area—being on the decline; and

(*iii*) After the flood water has totally receded.

Methods of Sowing.—The following methods are in vogue and any one or a suitable combination of these methods is employed on one and the same area, *viz*:

(*i*) Broadcast;
(*ii*) Dibbling;
(*iii*) Furrows;
(*iv*) Patches;
(*v*) Strips;
(*vi*) Trenches; and
(*vii*) Agriculture-cum-forestry.

(*i*) *Broadcast.*—This method of sowing is both pre-*abkalani* and *abkalani*. In pre-*abkalani* broadcast, just before the river water starts getting into the area, *babul* seed is broadcast by hand and in *abkalani* broadcast the seed is likewise scattered when the floods start receding. The seed sinks into the ground and is further covered by the silt deposited thereon by water It remains dormant so long as the water keeps standing and commences germinating a few days after water leaves the area. Regeneration by this method is not evenly distributed over the whole area. This method is generally augmented by other methods.

This method requires more of seed, because in many cases the sowing operations have to be repeated when, after the decline of the initial or second floods, the resultant regeneration is submerged and killed by fresh floods in the same season. In some seasons this operation has to be repeated twice. But the method is cheap, convenient and suitable for tackling large riverain areas.

(*ii*) *Dibbling.*—This consists of digging pits with a spade, about one foot diameter and 2—3 inches deep—the soil of these pits being broken loose. Some five grains of seed are then thrown in the pit and lightly covered with loose earth. This method is both pre- and post-*abkalani*. Pre-*abkalani* period is the same as described above for broadcast, post-*abkalani* sowings are undertaken after the decline of water, as soon as the ground is hard enough to bear the weight of man. A spacing of 6 ft. × 6 ft. is generally followed. This method is used for augmenting broadcast sowings also. By itself, it is more economical in the use of seed, the regeneration is evenly

spread and when carried out at proper time it gives very good results. The disadvantages of this method are that the period of operations for the post-*abkalani* sowings being very limited, vast areas cannot be undertaken. This method requires more men and consequently is more costly.

(*iii*) *Furrows.*—These are post-*abkalani* sowings. The operation is started as soon as the ground is dry enough to withstand the weight of oxen. To the handle of an ordinary country plough, drawn by a pair of oxen, a long wooden-pipe with a funnel-shaped top is tied. As the bullocks go on ploughing the area, the man behind the plough keeps on pouring the seed into the funnel with his hand and the seed thus falls right into the furrows. This procedure is the same as adopted for wheat and barley sowing. A careful man feeds the funnel evenly, when the resultant seedlings are more or less at equivalent distances. When properly carried out the method is very successful, specially where large alluvial areas are to be regenerated. This method is also used to augment broadcast sowings.

(*iv*) *Patches.*—This consists of sowing *babul* seed in selected patches of good soil in blanks and grassy areas by any one or combination of the methods described above. This method is both pre- and post-*abkalani*—more often the former.

(*v*) *Strips.*—This method is adopted in such areas as are given out for cultivation or in the alluvial areas which contain rank growth of young tamarisk. In cultivations parallel strips 2—4 foot wide are cleared at intervals of 20—40 feet and sown "Dibbling" or "Furrows". These sowings are *abkalani.*

Formerly in the alluviums, strips were sown *abkalani* "Broadcast" with post-*abkalani* "Dibbling" or "Furrows" but the present tendency is to utilize the cleared strips as paths and to sow the uncleared tamarisk belts *abkalani* "Broadcast" with post-*abkalani* "Dibbling" if required.

(*vi*) *Trenches.*—This method is employed in inland forests which are irrigated by canals. Selected high areas are cut into parallel trenches generally 10 feet apart and seed dibbled on one side of the trench 5—10 feet apart. The seed pit in this case is dug to a depth where the seed should be getting the requisite amount of moisture by percolation. These trenches are usually dug east to

west—the resultant earth being thrown on the north. The object is to afford the young seedlings protection from the winter frosts as also to allow them as much sunshine as possible. The usual width of the trenches on top is 1 foot.

(*vii*) *Agriculture-cum-forestry.*—Those high areas which cannot be irrigated in the ordinary way and such areas where irrigation by the Forest Department becomes a costly affair, are leased out for cultivation for one or more years. In the first year 2—5 feet wide parallel strips are sown with *babul* (Dibbling and Furrows) alternating with 20—40 feet wide cereal strips. In the subsequent years casualties in these strips are replaced and in the final year the whole area is broadcast with *babul* seed simultaneously with the cereal crop seed—any casualties in the strips being replaced. According to the terms of agreement the cultivator is generally bound down to irrigate the area for one year following the final year of cultivation by which time the *babul* regeneration gets established. This method is economical wherever practicable, inasmuch as in addition to deriving revenue in the shape of assessment, the Forest Department is able to afforest the area with no cost whatsoever other than the value of the seed which is supplied to the cultivator.

A mention may lastly be made about "mound" sowing. This was some time back introduced in the low lying areas where water level was high. The seed germinated quite well but on the decline of water the mounds dried very quickly and cracked, the seedlings not having tapped sub-soil moisture died of drought. This method has now been positively abandoned.

EXTRACTS

PYRETHRUM IN MYSORE

Demand for insecticides is growing as a result of the wider adoption of modern methods of controlling plant pests in agriculture, and of large-scale anti-malarial measures by the Public Health Departments. Higher standards of living and hygiene also lead to the increasing use of insecticides. At present by far the greater part of our requirements are met by imports. If these insecticides could be produced in India at lower prices, a very much larger quantity would be used to the great advantage of the community as a whole. And if an efficient insecticide could be had from a plant grown locally, a useful and profitable money crop would be at the disposal of the ryot. This in brief is the reason behind the attempts to grow pyrethrum in India.

Pyrethrum is a plant of the Chrysanthemum family; it is the flower of this plant (*Chrysanthemum cinerariaefolium*) which contains the active principle pyrethrin which is a powerful contact insecticide. At the same time, pyrethrum has no corrosive or irritating properties and has no adverse effects on animals even when taken internally in small doses. This unique combination of properties has made pyrethrum the vegetable insecticide *par excellence*.

The Forest Research Laboratory, Bangalore, took up the problem in 1937. At that time, there was a wide-spread belief that pyrethrum could not flower at altitudes less than 5,000 ft. This was scarcely encouraging for Mysore conditions. A beginning was, however, made with a few seeds of Japanese origin, and 558 plants were raised and planted at Bangalore (3,002 ft.) in the first instance in March 1938. Rigid laboratory experiments were conducted and data collected on the soil conditions, other conditions of growth, the treatment to be accorded to the individual plants and their rate of growth. The vegetative development of the plants was quite satisfactory, but it is the flower that provides the insecticide and a flowerless pyrethrum clump is very nearly a weed. It was therefore almost with relief that the first blossoms were noticed eleven months after transplanting, that is in February, 1939. About a third of the plants flowered.

This was distinctly encouraging. It did prove that pyrethrum could flower at the altitudes in the State. But what about the pyrethrin content? The insecticidal active principles of the flowers are chemically known as pyrethrin I and pyrethrin II. A number of careful analyses of representative samples showed that the total pyrethrin content of the Bangalore flowers was about 0.47 per cent. compared with 0.4 per cent. obtained from commercial samples purchased locally and 1.0 to 1.3 per cent. from the best Japanese samples.

The next step was to find out if selection and acclimatisation would improve the percentage of flowering as well as the pyrethrin content. These experiments were started in October, 1939, and the first results indicate that the percentage of flowering plants has been raised in the second generation to 50 while the pyrethrin content was about 0.8 per cent. It must be remembered that the best yields of pyrthrum are in the third year and onwards. The experiments are at present still in progress but these are now enough data to warrant the conclusion that pyrethrum grows and flowers under Mysore conditions and that the pyrethrin content of the flowers, while below the best recorded values of other places, is comparable to current commercial samples in the market.

Simultaneously with the experiments at Bangalore, experimental plantations of pyrethrum were raised by the Forest Department at other places in the State, selected for their varying altitudes and climatic factors. Among these, the growth at Kemmangundi (near Bhadravati) is promising.

The experiments at the Forest Laboratory are at present continuing. These are designed to collect enough seed and planting material to improve if possible the pyrethrin content and to record if the plant is susceptible to diseases and pests. It is also necessary to confirm the results obtained in the nursery by semi-commercial plantings on a much larger scale. The results of work so far may be summarized as demonstrating that not less than 75 lb. of dry pyrethrum flowers of between 0.5 to 0.8 per cent. total pyrethrin

could be produced per acre under Mysore conditions. The prospects of growing pyrethrum in Mysore would thus appear to be bright. This will shortly be put to large-scale tests.

—"Indian Farming," Vol. III, No. 8, dated August, 1942.

THE PROBLEM OF SHIFTING CULTIVATION IN HYDERABAD STATE

By Christoph Von Furer-Haimendorf, Ph.D.

Forestry in India is faced by a problem unknown in many other countries: the existence of primitive aboriginal populations who inhabit the forests and find a livelihood in manners considered by many as incompatible with the principles of forest conservancy. Yet the rights of these aboriginals to the hills and forests that have been their home since the oldest times are undeniable and ways and means have to be devised to reconcile their interests with those of the Forest Administration and turn their familiarity with the forest to uses beneficial both to themselves and the State. In many parts of India this has been achieved and the co-operation of the jungle tribes has proved invaluable in the exploitation of forest produce. But a stumbling block in the relations between the Forest Service and the aboriginal has often been the latters' practice of shifting-cultivation, which is, to use W. V. Grigson's words, "so often misrepresented as unmitigated evil."

Shifting-cultivation, known in India by such local terms as *podu* in Telingana, *bewar* in the Central Provinces and *jhum* in Assam, is the world's oldest method of agriculture. The main features of this system are the felling and burning of forest growth on hill slopes and the broadcasting or dibbling of the seed of various grain crops and sometimes of taro and yams in the soil prepared without the help of a plough. After a period of cultivation ranging from one to four years the land is abandoned and not taken again under cultivation until sufficient forest has grown up and the soil has recovered its former fertility.

Before the rise of the Eurasiatic high-civilisations, which marked the beginning of the era of plough-cultivation, no other forms of

agriculture than gardening and shifting-cultivation were known, and it is thus safe to say that until approximately the end of the fourth millenium B.C. the whole of humanity, as far as it had emerged from the earlier stage of food-gathering and hunting and evolved the raising of food crops, relied entirely on shifting-cultivation. But even after the invention of the plough its use remained long restricted to the Mediterranean countries, Europe, the Near-East, India, China and parts of Indonesia, whereas in by far the greater part of Africa, in the whole of America, as well as in the Pacific sphere, shifting-cultivation with hoe and digging-stick held the field until the Age of Discovery and colonization by European settlers.

In India shifting-cultivation was practised by a great part of the aboriginal population until the end of the last century, but it is now mainly found in the hills of Assam, certain tracts of Bihar, Orissa and the Central Provinces, in Bastar State and several smaller states of Eastern States Agency, in H. E. H. the Nizam's Dominions, some Districts of Madras Presidency and in Travancore and the adjoining parts of the Western Ghats. Within the boundaries of Hyderabad State tribes like the Koyas have only taken to permanent cultivation in the last few generations while the more primitive Hill Reddis of the Samasthan of Paloncha in the extreme south-eastern corner of Warangal District, and the Kolams and Naikpods of Adilabad District still rely largely on shifting-cultivation.

The Hill or Konda Reddis, among whom I spent recently the better part of a year, represent one of the most ancient strata of agricultural civilizations in Peninsular India and are thus of considerable ethnological interest. They inhabit the rugged mountain ranges of the Eastern Ghats to both sides of the great Godavari gorge and thus the tribe is divided between Hyderabad State and the East Godavari District of Madras Presidency. Their mountainous home land offers little scope for forms of agriculture other than shifting-cultivation on hill-slopes and even to-day this constitutes the principal means of subsistence for the greater part of the tribe. From time immemorial the Reddis have practised this method of tillage, while plough-cultivation, restricted to the small areas of flat land in the valleys, is a fairly recent innovation. Except for several larger

villages on the river-bank, the settlements of the Reddis are small clusters of houses high up in the forest-clad hills. Such a settlement may consist of only a solitary homestead or perhaps of as many as a dozen houses, but it is seldom of great permanency, for when Reddis shift their cultivation they often also move their houses so as to be near their fields.

When a Reddi has selected a hill-slope for cultivation he starts felling the jungle by the end of January. Large trees he cuts with his axe, generally two or three feet above the ground, the trunk being chipped on alternate sides, while his bill-hook serves for lopping smaller growth and branches, and for clearing undergrowth. Mango and jack-fruit trees are spared, for the Reddis consider their fruits too valuable to be sacrificed. The clearing of the jungle is hard work and those regarding *podu* as a lazy method of cultivation should compare the energy expended by a Reddi in felling trees cutting creepers as thick as a man's arm, clearing the thick brushwood and in burning the jungle, with the leisurely way in which the plainsman drives his plough through the soft soil of his oft-cultivated flat land.

Early in April the felled jungle is sufficiently dry to be burnt and after the first firing half-burnt branches are collected in heaps and completely reduced to ashes: the ashes are not distributed over the soil in any way nor is the ground sacrificed before the seed is sown. Charred tree trunks are left where they lie until the following year when they are burnt together with the lopped shoots from pollarded stumps and undergrowth before the sowing of the second year's crop.

The preparation of the hill-fields is generally completed by the beginning of May, but sowing is deferred till the first showers of the monsoon moisten the parched earth. Two methods of sowing on *podu* fields are practised by the Reddis: the broadcasting of the seed grain over the surface of the earth and the dibbling of the seeds into holes made with a digging-stick. Broadcasting is employed for the small millets such as *Panicum miliare, Panicum italicum* and *Eleusine coracana,* while jawari (*Sorghum vulgare*), maize and various kinds of pulses are dibbled. The small millets, jawari and pulses are usually sown as a mixed crop, the former being broadcast

first and the latter planted in holes when the small millets have sprouted. In the first year a *podu* field needs weeding only once, but in the second and third years of cultivation the more prolific growth of weeds must be eradicated twice. It has often been noticed that shifting cultivators, who till the soil without the help of ploughs, show a marked preference for hill-slopes even when flat land is available, and the reason for this lies probably in the fact that on the hill-slopes the weeds can just be kept under control, while in the more fertile soil of the valleys their vitality outstrips man's energy.

The crops grown on clearings in the heart of the forest are liable to the incursions of all sorts of game and from the time the first ears form watch must be kept both night and day; some Reddis surround their fields by fences with in-set traps for wild pigs, porcupines and jungle fowl. In August, before the first crop is gathered, the Reddi's *podu* resembles a garden rather than a grain field. There is a multitude of crops, all intermingled: the early ripening small millets with their delicate ears bowed and heavy with grain, some tinted gold and others of a purple hue, are interspersed with flowering pulses and the stout stalks of jawari, here and there are clumps of tall maize, and on the margin of the field the low growing fleshly leaved taro. Yellow flowering marrows ramble over the field hut and beans climb the tall poles of the bamboo watch-platforms. There is no great harvest, for each crop is reaped as it ripens and the Reddis, as though plucking flowers, thread their way through the rank growth, gleaning here and there a ripe ear.

A *podu* field is seldom cultivated more than three years in succession, and as soon as the soil shows signs of exhaustion the Reddi abandons it and cuts a new *podu*. The jungle soon closes in over the clearing, new shoots sprout from the stools and after ten or twelve years the soil has sufficiently recuperated to yield again one or two good crops.

In the high uplands of the East Godavari District bordering on Orissa *podu*-cutting is unrestricted and in the areas close to the Godavari River, where forest exploitation has begun, ample land has been set aside to allow the Reddis to follow their traditional mode of life. In the Samasthan of Paloncha, on the other hand,

the greater part of the forest was reserved some years ago and a line drawn at some distance from each village demarcated the area within which the Reddis were allowed to cut *podu*. In the villages on the Godavari this line included only the nearest slopes and at the time of my visit the Reddis complained that the area at their disposal was so small that they would be unable to give the land sufficient rest after each period of cultivation. If they had thus been compelled to shorten the cycle of rotation a gradual deterioration of the soil and erosion would have been unavoidable, but in accordance with a suggestion I put forward during my work among the Reddis, the allocation of land for *podu* of eight times the area actually under cultivation has since been provided for by the Circular Orders of the Court of Wards for the Paloncha Samasthan of 16-9-1350 Fasli and this has gone a long way towards safeguarding the basis of Reddi economy.

While the Reddi's right to practise shifting cultivation is in principle recognized both in Hyderabad and Madras Presidency, the position of the podu-cutting Kolams and Naikpods of Adilabad District is far less favourable. These two tribes stand on a level of economic development comparable to that of the Hill Reddis and their method of tillage is almost identical except that in addition to the digging-stick they use a spiked hoe to scratch over the soil after the seed has been sown. Whereas the Gonds of Adilabad dwell in the valleys and on the plateaux where level or only gently sloping ground allows of plough-cultivation, the Kolams and Naikpods lived until recent years on the steeper hill-slopes and subsisted entirely on the crops raised on their *podu*-fields. Like most shifting-cultivators they had no briefed rights in these frequently changing fields, and in this area the reservation of forest has made shifting-cultivation virtually illegal. The lands of many Kolam and Naikpod communities have been completely included in the reserves and the former occupants compelled to emigrate, and even where no such drastic steps were taken, only the slopes actually under cultivation at the time of the demarcation of the reserves have remained to the aboriginals. Thus they can no longer follow their traditional rotation of fields, and the rapidly deteriorating soil of overworked *podu* yield no longer adequate crops. Most Kolams and Naikpods have

no cattle and are unfamiliar with ploughing, and a transition to a different method of agriculture can therefore not be achieved within a few years or without outside assistance, even should plough-land be provided for those ousted from their former homes. Many have now found refuge in the estates of Mokashis, where forest-conservancy has not yet been introduced and they can continue their old mode of life, while others have left their forests and sought employment as agricultural labourers in the service of plains-people. Thus they are now scattered over many villages of more progressive castes and their tribal organization and culture has largely been broken up.

The argument which in Adilabad District, as in many other parts of India, has held to this policy in regard to shifting-cultivation is that such a form of tillage is wasteful and destructive and results in deforestation and soil-erosion. Against this can be said, however, that just those areas where shifting cultivators have lived for thousands of years are to-day richest in forest-growth, while many parts of the country inhabited by progressive plough-cultivators have long experienced an alarming shrinkage of the forest and a consequent deterioration of climate and soil. It seems indeed that neither in the Reddi country nor in the hills inhabited by Kolams and Naikpods has shifting-cultivation produced the ill-effects with which it is popularly accredited, and though the aboriginals have cut *podu* in their present habitat for many millenia, no signs of deforestation and soil erosion are visible and practically the whole of their country is covered by forest. The population has always been so sparse that natural regeneration has kept pace with their periodical fellings and consequently little harm has resulted to either forest or soil. The experience has been the same in most parts of the world where shifting cultivators were the sole inhabitants of wooded country, and J. P. Mills, C.I.E., I.C.S., the great expert in the administration of the tribal areas of Assam, has recently stated this in unequivocal terms: "Areas are known in Assam, where the same hill-sides have been 'jhumed' for hundreds of years without, apparently, losing any of their fertility. Wisely regulated 'jhuming' can therefore probably be carried on indefinitely without

causing deterioration."* W. V. Grigson, I.C.S., has come to the same conclusions in regard to the shifting-cultivation (bewar) of the Baigas in certain forest-areas of the Central Provinces and affirms his belief "that *bewar* could for all time be permitted here to Baigas without any harm to the forest or rainfall or the soil of the adjacent plains;" at the same time he emphasizes the need for provision against the danger that "an ill-considered order of an inexperienced officer, or the considered order of an older man prejudiced against *bewar* might at any time suddenly stop this, the only real means of livelihood of these wild Baiga."† The danger of deforestation is prone to arise only with the growth of progressive populations in the adjacent open country, who, in expanding, eat into the forest tracts, and narrow the shifting cultivator's habitat. This is clearly brought out by G. V. Jack and R. O. Whyte in their study on soil erosion: ‡ "Shifting-cultivation, although it kept men as unimportant servants of wild Nature, maintained soil-fertility indefinitely since the forest drove the cultivator out and resumed its beneficient control as soon as any signs of soil exhaustion appeared. Continuous cultivation meant continuous depletion of the soil and always more deforestation to secure new land for the rapidly growing community and to replace worn-out soils."

In the light of these facts it would seem that the restriction of *podu* to comparatively small and permanently demarcated areas near villages is a double-edged sword. For it forces the aboriginal either to shorten the cycle of rotation and cultivate again and again on land which has not fully recuperated, or to prolong each individual period of cultivation in spite of the noticeable exhaustion of the soil. The dangers of such a course are described in the study quoted above: "Native custom was to clear and cultivate small forest patches for one or two years only and then move on while there was still sufficient fertility left to enable the forest to regenerate itself. When the period of 'shifting-cultivation' is prolonged.............., fertility soon falls to a level below which natural regeneration will not occur. At the same time, the soil structure

**Some Recent Contact Problems in the Khasi Hills*, Essays in Anthropology presented to Rai Bahadur Sarat Chandra Roy, Lucknow 1942, p. 2.

†*The Aboriginals Problem in the Balaghat District*, Nagpur 1941, p. 33.

‡*The Rape of the Earth*, London, 1939, p. 23.

breaks down, and the soil is exposed to the exceptionally erosive force of tropical rains."

In making a decision of policy in regard to the aboriginal's *podu*, it will be therefore necessary to take into consideration that in its present form *podu* has had little destructive effect on the forest growth, while, on the other hand, the setting apart of too small an area for *podu* cultivation may lead to irreparable deterioration of soil in the assigned area. Against the argument that *podu* is a wasteful method of agriculture it must be held that the aboriginals find thereby a livelihood in areas where no other form of cultivation is possible and no other population could subsist. Moreover, from the point of view of forest exploitation, the presence of the aboriginals in their present habitat is of considerable value, since it guarantees a permanent supply of forest labour in regions so remote that the import of labour from the plains would meet with considerable difficulties.

A compromise between the legitimate rights of aboriginals and the requirements of forest-exploitation should not be too difficult to achieve, and the practice known by the Burmese term *taungya*, which provides for the replanting of forest trees on the relinquished fields of shifting-cultivators is the first step in that direction. Sacrifices and adjustment are undoubtedly necessary on the side of both Forest Administration and aboriginals, but there seems to be no reason why shifting-cultivation should not continue even in areas where communications are sufficiently developed for an immediate commercial exploitation of forests. For wherever coupes have been felled the aboriginals could be allowed to cultivate for one or two years, and the firing of the minor branches and under-growth, left after the removal of the timber of commercial value, would provide sufficient ashes to fertilize the soil for so short a period of cultivation. In most forest-areas of the Deccan there are, moreover, hill-sides and narrow valleys where the growth is too inferior or too difficult of access to allow of profitable exploitation and these could be set aside for the *podu*-cultivation of aboriginals who for the time being have no other means of subsistence. Such a compromise would spare the ancient sons of the soil the hardships of a sudden prohibition of their traditional occupation while no great loss would result to Government.

—*"The Hyderabad Forest Magazine", October, 1942.*

INDIAN FORESTER

APRIL, 1943

CHARCOAL FOR PRODUCER GAS PLANTS

BY J. V. KARAMCHANDANI, B.SC. (EDIN.), F.R.S.A.,

Deputy Conservator of Forests, and Forest Utilization Officer,

Bombay Province, Poona.

INTRODUCTION

What holds good in theory does not necessarily prove true in actual practice and the more we try to fit in with our laboratory findings, the more we get tied up in knots. Nothing has been truer than this in the case of charcoal producer plant. It is for some time now that work has been in progress and service tests conducted from time to time with a variety of charcoal to find out what would be the most suitable charcoal from the point of view of efficient performance in the producer gas plant and of cost. In Bombay Province this has involved dealing with several varieties of hardwood charcoal in pure as well as in mixed species. Charcoal has been manufactured from wood with and without bark under the personal supervision and control of the Forest Department and tested for ash, moisture, tar contents, fixed carbon, etc., as laid down in the specification by the Forest Research Institute, Dehra Dun.

Research of this kind takes time and we are living in an age which is moving too fast for us to keep pace with. Whereas we could cash our petrol coupons in Poona for petrol until the end of third week of May, 1942, we could not do so for love or money in

the latter part of the month and can do so now, *i.e.* towards the beginning of June and that also to the extent of two gallons at a time, by having a special permit from the District Magistrate. The petrol situation is likely to deteriorate rather than improve and that is why instead of finding out what would meet the bill, we should adopt our plants and so modify them, if need be, to suit what we have. It was with a view to get the other side of the picture that I have contacted distributors and owners of producer gas vehicles in Poona to get first-hand information and actual experience of the kind and quality of charcoal they are using. The result has been most illuminating and helpful. We at least now know where we stand with our charcoal when it comes to producer gas plants. In addition, I have endeavoured to collect information from past records of analysis, etc., as far as possible, and I believe, this coupled with the practical side of the question should help us to solve the problem.

SPECIFICATION FOR CHARCOAL.*

(1) Charcoal should properly be made from hardwoods.

(2) Charcoal should be made from sound wood only.

(3) The charcoal shall be properly and completely carbonised as indicated by its jet black colour and shall be free from unburnt or half-burnt wood as indicated by brownish pieces or patches.

(4) The charcoal shall show the original texture of the wood from which it is manufactured.

(5) The charcoal shall be firm to the touch and not easily crushed; when broken it shall not splinter or crumble, but shall present a clean fracture.

(6) The charcoal shall be free from wood bark and local ash. It shall also be reasonably free from grit, dust, fine particles of earth and mineral matter. The permissible limit of these is not more than 0.5 % of the air-dry weight of the charcoal tested.

(7) Standard size of charcoal passing through 1½" (square aperture) screen and retained upon a ⅜" (square aperture) screen.

(8) **The ash content** should not preferably exceed 4 % of the air-dry weight of charcoal.

(9) **The moisture content** will usually be from 5 to 10 %.

(10) A sample of the charcoal when lighted should burn with a short bluish flame, free from smoke or odour.

**Indian Forest Leaflet* No. 9 (Utilization)—Forest Research Institute, Dehra Dun.

RESEARCH

Analysis of Charcoal

S. No.	Scientific name.	Fixed carbon %		Volatile Hydro-carbon %		Ash %		Moisture %		Total.	
		H.D.	C.A.	H.D.	C.A.	H.D.	C.A.	H.D.	C.A.	H.D.	C.A.
1	2	3	4	5	6	7	8	9	10	11	12
1	*Terminalia paniculata* (K)	65.68	62.1	22.24	31.9	6.41	6.0	5.57	5.2	100	100.2
2	Do. (B)	68.79	64.3	19.65	31.9	5.58	3.8	5.98	5.3	100	105.3
3	*Xylia xylocarpa* (K)	77·92	52.6	11.84	45.2	3.98	2.2	6.26	4.8	100	104.8
4	Do. (B)	79.32	41.5	13.34	55.5	2.50	3.0	4.84	3.7	100	103.7
5	Mixed (K)	72.05	72.8	15.96	23.6	5.23	3.6	6.76	6.7	100	106.7
6	Do. (B)	76.33	73.2	11.25	17.7	7.92	9.1	4.50	4.4	100	104.4
7	*Casuarina* sp.	84.22	72.3	9.28	26.2	1.47	1.5	5.03	4.9	100	104.9
8	*Terminalia tomentosa* (K)	67·98	64·7	20·76	30·2	5·19	5·1	6·07	5·4	100	105·4
9	*Chloroxylon swietenia* (B)	82.70	62.5	8.40	33.0	3.50	4.5	5.40	4.8	100	104.8
10	*Anogeissus latifolia* (B)	69.33	70.3	13.21	17.8	12.58	11.9	4.88	4.4	100	104.4
11	*Albizzia amara* (B)	80.39	80.3	8.91	15.1	4.58	4.6	5.85	5.4	100	105.4
12	Hardwood Madras	71.43		18.81		4.24		5.52	..	100	..
13	*Casuarina* Madras	71.01		19.39		4.25		5.35	..	100	..
14	*Tamarindus indica* Madras.	70.93	..	17.30		5.87		5.90	..	100	..
15	Hardwood mixed-Dahanu Road (B.P.)	56.81	..	22.06		9.91		11.22	..	100	..

H.D. = Messrs. Huges and Davis, through Ford Co.

C.A. = Chemical Analyser to the Government of Bombay.

K. = Karwar District.

B. = Belgaum District.

B.P. = Bombay Province.

CARBON CONTENT *Percentage*

Scientific name.		Vernacular.	H. D.	C. A.
Casuarina equisetifolia		Casuarina ..	84.22	72.3
Chloroxylon swietenia	(B)	Mushawal ..	82.70	62.5
Albizzia amara	(B)	Tugli ..	80.39	80.3
Xylia xylocarpa	(B)	Jamba ..	79.32	41.5
Do.	(K)	,, ..	77.92	52.6
Hardwood mixed	(B)		76.33	73.2
Do.	(K)		72.05	72.8
Anogeissus latifolia	(B)	Dindal ..	69.33	70.3
Terminalia paniculata	(B)	Kindal ..	68.79	64.3
Terminalia tomentosa	(K)	Matti ..	67.98	64.7
Terminalia paniculata	(K)	Kindal ..	65.68	62.1
Hard woods Madras			71.43	
Casuarina equisetifolia Madras		Casuarina ..	71.01	
Tamarindus indica Madras		Tamarind ..	70.93	
Hardwoods mixed Dahanu Road, (B.P.)			56.81	

H.D.=Huges and Davis, through Ford Co.

C.A.=Chemical Analyser to the Government of Bombay.

K.=From Karwar District.

B.=From Belgaum District.

B.P.=Bombay Province.

ASH CONTENT (*Percentage*)

Scientific name.		Vernacular.	H. D.	C. A.
Casuarina equisetifolia	..	Casuarina ..	1.47	1.5
Xylia xylocarpa	(B) ..	Jamba ..	2.50	3.0
Chloroxylon swietenia	(B) ..	Mushwal ..	3.50	4.5
Xylia xylocarpa	(K) ..	Jamba ..	3.98	2.2
Albizzia amara	(B) ..	Tugli ..	4.85	4.6
Terminalia tomentosa	(K) ..	Matti ..	5.19	5.1
Hardwood mixed	(K) ..		5.23	3.6
Terminalia paniculata	(B) ..	Kindal ..	5.58	3.8
Do.	(K) ..	do. ...	6.41	6.0
Hardwoods mixed	(B) ..		7.92	9.1
Anogeissus latifolia	(B) ..	Dindal ..	12.58	11.9
Casuarina equisetifolia Madras	..	Casuarina ..	4.25	
Tamarindus indica Madras	..	Tamarind ..	5.87	
Hardwoods Madras	..		4.24	
Hardwoods mixed Dahanu Road (Coupe wood) B. P.	..		9.41	

H.D.=Huges and Davis, through Ford Co.

C.A.=Chemical Analyser to the Government of Bombay.

K.=From Karwar District.

B.=From Belgaum District.

B.P.=Bombay Province.

Note.—The ash contents of the woods which have been recently determined by the Chemistry and M. F. P. Branch of the Forest Research Institute, Dhera Dun, from the samples received from Bihar, Orissa, Punjab and Sind show that the mineral content in branch wood depends upon its age. Those that are thick usually show higher ash content and this explains the wide variation in the maximum and minimum.

Further the ash content of charcoal is about three times the ash content of wood depending upon the yield of charcoal from the wood in question.

By Huges and Davis:

	Madras Forest Hardwood %	Dahanu Rd. Coupe wood %	Madras Tamarind %	Madras Casuarina %
Fixed carbon ...	71.43	56.81	70.93	71.01
Volatile Hydrocarbons (Tarry matter, creosote, etc.) ...	18.81	22.06	17.30	19.39
Ash ...	4.24	9.91	5.87	4.25
Moisture ...	5.52	11.22	5.9	5.35
	100.00	100.00	100.00	100.00

	Xylia xylocarpa (jamba) %	*Olea dioica (par jambul)* %	*Memecylon edule (Anyani)* %	*Lagerstroemia lanceolata (Leuda)* %
Fixed carbon ...	71.65	60.62	64.58	79.01
Volatile Hydrocarbons	20.50	29.15	26.79	12.64
Ash ...	2.50	4.01	2.74	2.13
Moisture ...	4.86	6.22	5.89	6.22
Lime content cao of ash	64.24			

By Chemical Analyser to the Government of Bombay:

Terminalia tomentosa (ain-matti)

	Fixed carbon %	Volatile hydro-carbon %	Ash %	Moisture %
Trunk wood ...	73.92	16.62	6.43	3.03
	66.05	20.54	8.29	5.12
Branch wood ...	67.97	23.16	5.59	3.28

NOTE: *Terminalia tomentosa* which possibly does not contain a big percentage of carbon but does contain too big a percentage of chemicals such as lime which have a bad effect on the gas producer. Apparently a deposit of lime forms above the surface and so prevents proper combustion of the charcoal.

ROAD TESTS

By Ford Co.:

(*i*) *Ain* (*Terminalia tomentosa*)—*Branchwood*.—After travelling 120 miles a distinct loss of power and maximum speed of 20 M.P.H. obtained, on inspection of hopper large quantities of lime deposit and ash was found.

(*ii*) *Ain* (*Terminalia tomentosa*)—Trunk wood.—Much better performance on flat road but could only take the ghats on low gear. Maximum speed over the last 20 miles being 28 M.P.H. Inspection of hopper indicated large quantities of lime and ash deposit.

Note: *Ain* (*Terminalia tomentosa*) charcoal made from wood with bark and without bark, both from dry wood and green wood, all the tests have given the same results, *viz.* that *ain* charcoal no matter how well it is made is *not* suitable for the Ford Company's outfit owing to the large amount of lime present in the wood. The lime forms a cap over charcoal furnace and after a trip of 120 miles, the engine ceases to function.

(*iii*) *Dhavra* (*Anogeissus latifolia*) charcoal specially prepared supplied to Ford Co. showed no improvement over the *ain* charcoal; the lime content being very high.

(*iv*) *Jamba* (*Xylia xylocarpa*) supplied to the Ford Co., has been found fairly satisfactory. Very little clinker and no sign of lime.

(*v*) *Babul* (*Acacia arabica*) charcoal (specially hand picked) was supplied to Ford Co. from Poona Division and has been found to be good.

By Marsland Price and Co.:

(*i*) Mixed charcoal (from Neral-Kolaba District)—not satisfactory. High percentage of ash.

(*ii*) Mixed charcoal from Belgaum—not very satisfactory.

By the Forest Utilization Officer, Bombay Province on 19-7-1942:

Make of the Producer Gas Plant	...	Simpson.
Model and type of vehicle	...	$1\frac{1}{2}$ ton 1941 Chev. Passenger.
Load	...	12 passengers excluding driver.

Mixed hardwoods:

Distance covered		
Total travelling time taken	...	2 hours and 10 minutes.
Average speed	...	21 M.P.H.
Weather conditions	...	Wet.

Remarks in general: Cruising at 30 M.P.H., no difficulties were experienced and engine was running smooth. Examination of filters showed no deposits of ash but certain amount of moisture.

Babul charcoal (*Acacia arabica*):

Distance covered	... 52 miles (Bombay Poona Road)
Total travelling time taken	... 2 hours and 45 minutes.
Average speed	... 19 M.P.H. (nearly).
Weather conditions	... Wet.

Remarks.—Cruising at 40 M.P.H., no difficulties were experienced whereas at 30 M.P.H. one could feel that there was sufficient reserve of power. Besides, the pick-up was quick and engine responded readily to the pressure of accelerator.

The above test included a hill climbing test of 4 miles—Bhor Ghat.

Hill Climbing Test:

Distance covered	... 4 Miles.
Total travelling time taken	... 37 minutes.

Remarks.—The total distance was covered in 1st and 2nd gear with occasional change in the 3rd gear. There was no difficulty and the distance was covered at one stretch without stopping.

Mr. Cama of Kirkee:

Babul charcoal (*Acacia arabica*).—Passenger bus for station use, *i.e.* transporting school children from and to schools in Poona.

Remarks.—*Babul* charcoal (*Acacia arabica*) has given great satisfaction. The Engine starts easily, runs faster and consumes less charcoal than other charcoals.

SERVICE TESTS

1. *T. V. S. Plants*

(*i*) *Messrs. India Garage*, Poona, who are agents for this plant for the Province have fitted over 100 vehicles with T.V.S. Producer Gas Plant. They have three goods vehicles fitted with their plant for their use and their experience both as distributors and owners and that of others who are using this plant can be summarised up as:

Charcoal used: From Khopoli (Kolaba District) and Itarsi (C.P.).

Opinion: No clinker. More ash content. Itarsi charcoal better than Kolaba charcoal.

(*ii*) Messrs. Loyal Motor Service Poona—

Route on which plying: Poona to Mahableshwar.

Charcoal used: From Mahableshwar and Wai.

Opinion: On the whole satisfactory. Not enough pulling power.

(*iii*) Messrs. Poona Bombay Union Motor Service, Poona—

Route: Poona to Bombay.

Charcoal used: Local and from Bhor State.

Opinion: Satisfactory. No trouble with volatile Hydrocarbons, etc.

2. *Simpson's Plant*

(*i*) *Messrs. Deccan Motor Service, Poona,* are the local agents and have fitted fair amount of vehicles with this producer gas plant. Their experience and that of their clients is:

Charcoal used: From Khopoli (Kolaba District) and C.P.

Opinion: Satisfactory. Khopoli charcoal needs drying before use. No clinker formation.

General complaints: Higher moisture content. Tar contents. Loss of Power.

NOTE.—In addition, Messrs. Deccan Motor Service, Ltd., have also used charcoal from other localities and in their opinion Indore charcoal is the best, *i.e.* on par with Madras charcoal (presumably *Casuarina* charcoal) and Bijapur charcoal as the second best.

Their conception of best charcoal is that it should ignite instantaneously further the maximum time that it should take to come from petrol to gas should not exceed 5 minutes whereas the local charcoal they are using takes 8—10 minutes to come on gas.

(*ii*) *The Bombay Garage, Bombay*—

Route: Bombay suberban area (Bus service).

Charcoal used: From Dahanu Road.

Opinion: Satisfactory. Contains less moisture than Khopoli charcoal.

(*iii*) *The Poona Bombay Union Motor Service, Poona*—

Route: Poona to Bombay.

Charcoal used: From Bhor State and local.

Opinion: Satisfactory.

(*iv*) *Messrs. Paranjpe Motor Service Ltd., Poona*—

Route: Poona to Bombay.
Poona to Panvel (Kolaba).
Poona to Bhor State.

Charcoal used: From Bhor State.

Opinion: Satisfactory.

(*v*) *Messrs. Mulshi Motor Association, Poona*—

Route: Poona to Bombay.

Charcoal used: From Khopoli, Bhor State and C.P.

Opinion: Satisfactory C.P. Charcoal more satisfactory.

(*vi*) *Shri Datta Motor Co., Poona*—

Charcoal used: Local and from Bhor State.

Opinion: Satisfactory. Slight clinker formation.

3. *Steel Products* (Shiavax Plants)

(*i*) *Messrs. Silver Jubileee Motor Works Ltd., Poona*—

Route: Poona to Sholapur.

Charcoal used: Local.

Opinion: Satisfactory.

(*ii*) *Messrs. Mulshi Motor Association, Poona*—

Route: Poona to Bombay.

Charcoal used: From Khopoli, C.P. and Bhor State.

Opinion: Satisfactory. C.P. charcoal more satisfactory. Khopoli charcoal contains higher percentage of moisture in comparison to Bhor State charcoal.

(*iii*) *Messrs. Paranjpe Motor Service Ltd., Poona*—

Route: Poona to Bombay.
Poona to Panvel (Kolaba).
Poona to Bhor State.

Charcoal used: From Bhor State.

Opinion: Satisfactory.

(*iv*) *Shri Datt Motor Co., Poona*—

Charcoal used: Local and from Bhor State.

Opinion: Satisfactory. Slight clinker formation.

4. *The Federal Plants*

(i) *Shri Ganesh Motor Co., Poona*—

Route: Poona to Kolaba.

Charcoal used: From Khopoli and Bhor State.

Opinion: Satisfactory. Bhor State preferred. No clinker formation.

(ii) *Laxmi Motor Service Ltd., Poona and Nasik*—

Route: Poona to Nasik.

Charcoal used: From Nasik.

Opinion: Satisfactory. Slight tar contents.

5. *Amraoti Plant*

(i) *Mr. G. K. Gadhe*—

Charcoal used: From Nasik.

Opinion: Satisfactory.

CHARCOAL: *SPECIES USED FOR MANUFACTURE OF*—

Khopoli (District Kolaba):

Terminalia tomentosa, Acacia catechu Anogessius latifolia (forming 40 per cent.) with *Holoptelea integrifolia Tamarindus indica*, etc.

Central Provinces:

Terminalia tomentosa 80 per cent. with some *Anogeissus latifolia, Schleichera obosa* and an occasional *Terminalia arjuna.**

Or

Terminalia tomentosa, Anogeissus latifolia and *Acacia catechu.*

Dahan Road (District Thana):

Terminalia tomentosa, Terminalia belerica, Anogeissus latifolia, etc.

Bijapur:

Albizzia lebbek, Chloroxylon swietenia, Stereospermum chelonoides, and *Anogeissus latifolia.*

Indore (Holkar State):

No information available, as charcoal produced is not being used for the purpose.†

---

* The Chief Conservator of Forests, C.P. and Berar.

† The Conservator of Forests, Holkar State, Indore.

Thana:

Terminalia tomentosa, Anogeissus latifolia, Terminalia belerica.

Bhor State:

*Acacia catechu, Terminalia tomentosa, Schleichera trijuga, Lagerstroemia lanceolata, Anogeissus latifolia, Terminalia balarica and Adina cordifolia.**

REMARKS

Judging from the schedule of the analysis, *i.e.* theoretically, none of the charcoal, being used at present for the gas plants, should give satisfaction since in all cases but one (*i.e.* charcoal from Bijapur) consists predominantly of *Terminalia tomentosa* and *Anogeissus latifolia,* whereas in actual practice it is not only being used (not because of want of better charcoal) but is even reported to give satisfaction. It will be more accurate to say that it is good for certain plants and not good enough for other plants.

The chief complaints about charcoal, as reported to me, and arranged in order of merit are:

(*i*) *Moisture content.*—Higher percentage of moisture content is more a physical phenomenon than a chemical one and is an inherent property of charcoal. It, apart from how liberally charcoal is quenched with water, depends or rather varies with the atmospheric conditions and humidity. It can therefore be easily controlled and remedied by drying charcoal before use.

(*ii*) *Tar contents.*—In my opinion, this appears to be due to insufficient or improper carbonisation and with better control over maunfacture of charcoal which is being enforced now, the tar contents can be reasonably reduced if not eliminated.

(*iii*) *Ash contents.*—Ash contents depend upon the size of billets used, according to Chemistry and M. F. P. Branch of the Forest Research Institute, Dehra Dun. In other words, thick parts show higher ash content. This is further borne out by analysis where the ash content of charcoal from trunk wood is higher than charcoal from branch wood.

* The Forest Officer, Bhor State.

Besides, the ash factor varies with the gas plant. Though we know that species used in the manufacture of charcoal, being utilized at present, do contain a high percentage of ash, still there is no general complaint about it in actual service. As a matter of fact people are making a song about moisture content rather than ash content. When I questioned them on this point, I was told that it depended upon the efficiency of the plant?

(*iv*) *Not enough pulling power.*—This may be attributed to one or more factors and quality of charcoal may not be playing so important a role as some or all of the following reasons:

(*a*) *Condition of engine.*—Most of the vehicles—if not all—which are being converted from petrol to gas are not new and a very fair proportion of these may be old veterans. The latter on petrol even would puff and steam along, negotiating an ascent with hard labouring by stages and when it comes to gas—where we certainly have a drop* in efficiency of functioning—we cannot reasonably expect as good results.

(*b*) *Handling.*—One can never get the best out of a vehicle (on petrol) unless he or she is an expert at it. The same holds good in case of gas plants more so when driving on gas is quite different from driving on petrol. The class of people handling it are still new to the game and need to be educated to the new requirements, if maximum results are to be obtained. The power loss of 30—35 per cent. (*vide* *) can be considerably reduced to between 25 per cent. to 30 per cent. by increasing the compression ratio and advancing the ignition, etc.

(*c*) *Maintenance.*—The gas plant needs more and constant attention and looking after in as much as that hopper ash chamber and grates need changing every day, the gas filter element once

---

* Comparing the calorific values of mixtures in each case about to enter the engine cylinders, a normal producer-gas-air mixture is approximately 600 calories per cubic meter as against 800 calories per cubic meter for a normal petrol-vapour-air mixture. The values agree roughly with the generally recognized power loss of 30 to 35 %—*Economic Transportation by the Bombay Garage, Bombay.*

every 200—250 miles, as gas cooler radiator plugs every 400—500 miles, etc.*

CONCLUSIONS

If this is all what we have against our charcoal, the problem then is, in my opinion, not so very difficult. The remedy lies more in control of manufacture of charcoal than using exclusively A. I. species and if former is done then half our worries will be over and we can leave the experts to carry on with the good work and give us what they think best.

Finally I want to make it quite clear and particularly to any whose profession it may be, that I am not an engineer by profession, and very much less so by occupation, and further put forward no claims in that direction. The only angle from which I can speak with certain confidence or authority on this subject is from the commonsense point of view based on facts and figures collected from everyday life, for is not commonsense apt to be regarded as being in the nature of a brake upon futility of invention, a 'safety first' slogan—jogtrot, and caution, as opposed to 'hell for leather' and adventure?

NOTE.—Arrangements for departmental supply of approximately 40,000 tons of mixed hardwood charcoal during the year have now been made by the Forest Department for use of the vehicles on gas in the Province of Bombay.

The distribution will be made to bonafide consumers through combines and agencies appointed by the Regional Transport Officers within their respective Regions.

The price at which charcoal is to be supplied to the accredited agencies has been fixed at Rs. 1-14-0 a maund, i.e. Rs. 52-8-0 a ton F.O.R. or F.O.B. or Ex-roadside depot whereas prevailing control price for bazar charcoal in Poona is Rs. 3 a maund, *i.e.* Rs. 84 per ton.

**Economic Transportation by the Bombay Garage, Bombay.*

APPENDIX I

Statistics relating to the Producer Gas Plant (Simpson) in operation on Belgaum-Dharwar Road as compiled by the Forest Engineer, Bombay Province, Belgaum.

Description	April 1941	May 1941	June 1941	July 1941	Total.
No. of days run	12	25	17	18	72
Distance run (miles)	994	2518	1848	1728	7088
Amount of charcoal used (Lbs.) ..	1888	3953	2710	2498	11049
Cost of charcoal used (Rs.) ..	21.7	44.12	30.24	39.03	134.46
Amount of petrol used (gallon) ..	7	38	27	28	100
Cost of petrol used (Rs.) ..	12.69	68.87	38.93	51.62	182.11
Total of petrol and charcoal (Rs.) ..	33.76	112.99	79.17	90.65	316.57
Cost of fuel per mile (Annas) ..	0.54	0.67	0.68	0.83	..
Cost of fuel per mile if petrol (Annas)	2.41	2.41	2.41	2.46	..

Species of charcoal used :

Anogrissus latifolia.

Xylia xylocarpa.

Terminalia paniculata.

Chloroxylon sweitenia.

Terminalia tomentosa.

Albizzia amara.

Mixed hardwoods.

Species of charcoal preferred :

Anogeissus latifolia.

Xylia xylocarpa.

Terminalia paniculata.

Effect on Engine :

Run just over 10,000 miles with a minimum of trouble and in consequence it has not been found fit to dismantle the engine for decarbonizing.

Owners' opinion.—Smooth running. Filters cleaned daily, carburettor once a week.

APPENDIX II.

Public Utility Companies Madras

(Charcoal supplied by the Madras Forest Department)

Scientific name.	Quantity tried lbs.	Mileage run.	Consumption per mile lbs.	Clinker content.	Tar content.
Casuarina spp. ..	207	148	1.4	Nil	Nil
Melia indica	208¼	139	1.5	do.	do.
Cleistanthus collinus ..	246½	155	1.58	do.	do.
Anogeissus latifolia ..	312	195	1.6	do.	do.
Acacia arabica ..	220	129	1.72	do.	do.
Acacia sundra ..	269½	152	1.77	do.	do.
Albizzia amara ..	232	121	1.92	Very slight traces.	
Hardwickia binata ..	280¾	140	2.0	Nil	Nil

NOTICE

It is hereby notified for general information that all the Forest Research Institute publications hitherto available from the Forest Research Institute, P. O. New Forest, Dehra Dun, are now obtainable from Messrs. Jugal Kishore & Co., Agents for Government of India publications, Rajpur Road, Dehra Dun. All orders may please be addressed to that firm. Limited stock for sale to visitors only will be kept at the Institute.

RESCUE OF A RHINO

BY M. C. JACOB

Deputy Conservator of Forests

Assam has a number of game sanctuaries where the Indian rhino is protected and allowed to breed and multiply. While the Kaziranga Game Sanctuary in the district of Sibsagar is the most famous of these, where the curious can, any day, hire departmental elephants for a small fee and 'view' rhinos, there are other sanctuaries less famous where the lucky can, after strenuous and persistent effort, come across these ponderous pachyderms. The incident narrated below occurred in one of these lesser-known resorts of the Indian rhino, the Orang Game Reserve in the district of Darrang.

Forest guards on patrol in this reserve, early in the month of January this year, came across a cow rhino hopelessly bogged in one of the numerous swamps occurring in it. While there are about half a dozen rhinos estimated to occur in this reserve and the patrols were accustomed to see the one or two of these wallowing in these swamps, this was the first time they had seen one not enjoying itself thoroughly but obviously in hopeless distress. She was completely immersed in the slimy mud of swamp except for her head and the top of her spine. Her efforts to extricate herself had apparently only resulted in her getting deeper into the 'ponk'. When first seen she had, probably very sensibly, given up all attempts at getting out by her own motive power and had apparently resigned herself to a slow death by starvation.

Word was immediately sent by the patrols to the forest ranger at his headquarters and he at once proceeded to the spot. Food and drink being the first necessities of life buckets of water were thrown down into the semi-solid mud in front of her and while the rhino refreshed herself with what was probably her first drink for a number of days coolies got busy cutting bundles of grass for feeding her. Very sensibly she did not demur at accepting the victuals thus provided.

The resourceful old ranger now set about initiating rescue operations. Jute ropes were hastily made ready and setting a good example the ranger himself descended gingerly into the swamp with

his staff and delving in the mud passed the rope all round her body and tied it securely round her leaving a length of about a hundred feet for towing. A noose was tied at the end of another rope and passed round her neck and secured. A pair of buffaloes and a posse of about fifty men were now detailed to do the dragging from the solid bank of the swamp. About two hours of effort interspersed with breakings and re-fastenings of the ropes and expenditure of much foul language it is to be feared, resulted in the heipless pachyderm being dragged forward a few feet; but appearances had been deceptive and what had seemed more solid ground really turned out to be even more 'ponky' and the rhino was stuck in deeper mud than ever. Daylight was now fast failing and so after pouring more water in front of the rhino for her libations and throwing more bundles of grass in front of her for her dinner it was decided to call it a day. While success had not been achieved, still the prospects were good. If one pair of buffaloes and fifty men could drag the brute a few feet in about two hours, two pairs of buffaloes and about hundred men should be able to do the job the next day easily! The young lady herself was being very helpful two, drinking and eating without demur!

Work was started soon after dawn next day. One party was detailed off to get stout fresh jute ropes prepared. Another was asked to get busy preparing a solid bed of tightly-bound bundles of jute sticks and grass in front of the rhino in the direction of the pull so that when hoisted on it she should not sink again. A solid causeway having thus been prepared and the rhino having been tied up as on the previous day an hour's hauling saw her safely hoisted on the causeway.

A multitude of about five hundred men, women and children had collected to have their first look at this famous breed of monster and watch proceedings; advice galore was forthcoming how to conduct operations and remarks rife about the attributes of the genus and the medicinal and other values of the different parts of its anatomy; but the crowd was very thin indeed as the brute was hoisted on to solid ground; for who would face an indignant young lady thus roughly handled once she was free to act?

Nothing electric happened for a few minutes while she was re gaining her breath; then things began to move fast. She stood up limply and, base ingratitude, groggily attempted a charge at the nearest thing bearing a semblance of humanity, to wit, an earthen pot which had been used for slaking her thirst and which had been covered by its owner's spare rags. This having been smashed up she looked round for more victims but the few men that had been about including the old ranger preferred to watch proceedings from a safe disance.

Thus foiled she quietly ambled off with a piece of the rope still round her neck and watchers from tree tops could see her setting assiduously about her routine business of consumption of large quantities of grass.

Experts say that she was an expectant mother and that was why she could not extricate herself from the swamp.

May her tribe increase!

INDIAN KAPOK

BY T. P. GHOSE,

Chemistry and Minor Forest Products Branch, F.R.I.,

Dehra Dun

Summary.—The demand for *kapok* has increased considerably both for the manufacture of life-belts and other life-saving appliances as well as for its newer uses like the manufacture of felted *kapok* and *kapok* textilor yarn. The Java *kapok* (*Ceiba pentandra* floss) used to meet the bulk of the demand, and the Indian *kapok* (*Bombax malabaricum* floss), which at one time used to be considered as of inferior quality, has now been recognised as equal to the Java *kapok* in buoyancy, weight-bearing capacity and freedom from water-logging and its use in making life-belts, etc., has been approved of both by the Mercantile Marine Department, Calcutta and the Marine Surveyors of the British Ministry of Transport.

The above, coupled with the fact that supplies from Java have now stopped, have opened enormous commercial possibilities for the Indian *kapok*. Detailed information on Indian *kapok* is given and attention of all concerned is being drawn to the necessity of increasing the production and of marketing *kapok* of high standard, free from adulteration.

Silk cotton or the soft silky floss attached to the inner walls of the capsules of many plants belonging to families *Malvaceæ, Apocyanceæ, Asclepiadaceæ,* etc. have long been used in stuffing

*Published also as *Indian Forest Leaflet,* No. 32 by the Forest Research Institute, Dehra Dun.—*Ed.*

pillows, mattresses, etc. The most important of these flosses, from a commercial point of view, is *kapok* or the floss derived from *Ceiba pentandra,* Gaertn. Syn. *Eriodendron anfractuosum* DC. This species, although indigenous to many parts of the world, is largely cultivated in Java, which meets the major portion of the world demand for *kapok*. *Ceiba* grows in India (to a limited extent in the Western Coast) also, but no efforts appear to have been made to cultivate it on a commercial scale. The possible reason for it is that India produces another floss very similar to the Java *kapok,* which is called the Indian *kapok,* and is derived from *Bombax malabaricum* DC. This species is very common throughout India, and large quantities of the floss are available for commercial purposes, though the export trade is limited. This is due to the fact that sufficient attention has never been paid to carefully collect the floss, and to purify and prepare it for the foreign market, with the result that it has always been looked upon, in the past, as inferior to the Java *kapok,* which is a cleaner and carefully prepared material.

Commercial importance of *kapok* increased considerably when it was found that because of its buoyancy, freedom from water-logging and great weight bearing capacity, it was a much superior material than cork and reindeer hair for making life-buoys, life-belts and other naval life-saving appliances. This discovery created a considerable demand for the Java *kapok*. It was a difficult task for the Indian *kapok* to establish its quality against Java *kapok* in this important industrial application, in absence of any certified tests. The Imperial Institute, London in 1919 (ANON., 1919. *Bull. Imp. Inst.,* 17: 14—22), undertook to test the Indian *kapok* and after a very careful investigation established to the satisfaction of the Board of Trade, England, that in buoyancy, freedom from water-logging and weight bearing capacity the Indian *kapok* was equal to, if not superior to the Java *kapok*. But the trade prejudices, like all other prejudices, die hard and the Indian product, inspite of these tests, failed to secure its due share of the trade in *kapok*. The prejudice against the Indian *kapok,* however, was not without justification, because some of the *kapok* exported from this country was not only contaminated with sand, seeds,

portions of pods, etc. but also was adulterated with the floss of *Calotropis procera* (*akund*) which is inferior in quality and gets quickly water-logged. Conditions have improved since and machine cleaned *kapok* has been put in the market enabling India to retain a certain volume of the export trade.

Kapok floss, on account of its smooth silky surface and the lack of natural axial twist, is not suitable for textile purposes. Furthermore, the fibres are weak and cannot stand carding in machines meant for cotton. These difficulties have now been overcome by suitably processing and introducing modifications in the carding machine, before spinning and weaving. The Imperial Institute, London, in an exhaustive report on *kapok* and its commercial possibilities, have pointed out that the yarn so produced was suitable for the manufacture of plushes, lace and a few other special articles, but could not be used in place of cotton. On account of its non-conducting character it might, however, find a special use as an interlining in warm clothing (ANON., 1926. *Bull. Imp. Inst.*, 24 : 22). It is now being used in wadding or quilted padding. It is also being felted and various materials are woven with *kapok* textilor yarn. The fact that it can be dry sterilized (at 110°C) without any loss of property, makes it an excellent material for making padded surgical dressings. All these have led to an increased demand for *kapok*. Attention of all interested in the development of trade in the Indian *kapok* is, therefore, being drawn to the commercial possibilities of this product.

PROPERTIES OF KAPOK

Kapok consists of cylindrical one-celled brittle hairs. It is light, buoyant, elastic and has a smooth shining surface. It is six times lighter than cotton. Being resilient, it does not get matted under pressure. Being water repellent, it does not easily get wet and when it does so, on prolonged contact with water, it can easily be dried. Its water repelling property also imparts to it certain degree of immunity against attack by fungus and moulds. Rotting of covers of life-belts, etc., stuffed with *kapok*, is therefore,unusual (BARTOLOME, V.C., 1927. *Trop. Agr.* 68: 107). "The waxy coating on the fibre, which gives to it the glossy appearance, is not said to

be pleasing to vermin. *Kapok* mattress is, therefore, considered to be vermin proof. [ANON., 1914. *Scientific American* (Supplement), 77: 213].

The floss of *Bombax* resembles the *Ceiba* floss in the above mentioned properties except that it is slightly more brownish-yellow. The length and diameter of the fibres and their densities are more or less the same in both Indian and Java *kapok*.

	Java *kapok*.	Indian *kapok*.
Length of the fibre ..	0·6 to 1·1 in.	0·7 to 1·1 in.
Diameter of the fibre ..	0·0006 to 0·011 in.	0·0006 to 0·0013 in.
Density at 30°C ..	0·0388.	0·0554.

It is generally held that in resiliency Indian *kapok* is slightly inferior to Java *kapok*, but in buoyancy, weight bearing capacity and freedom from water-logging both are equal. It loses only 10 per cent. of its buoyancy after being in water for 30 days and after drying fully regains its buoyancy and resiliency. Indian *kapok*, in a reasonably clean condition and free from adulteration with *Calotropis* floss, fully satisfies all the specifications laid down by the Board of Trade, England. The following table (ANON., 1919 *Bull. Imp. Inst.*, 17: 19) gives the results of tests made on machine cleaned *Bombax* and *Calotropis* floss as compared to Java *kapok*.

These results of the Imperial Institute were again checked by the Mercantile Marine Dept., Calcutta, and the Marine Surveyors of the British Ministry of Transport. Life-belts, etc., are now being manufactured in India from Indian *kapok* by Messrs. Royal Laundry Company of Bombay and Messrs. Hnyshe Co., of Calcutta. Other companies are also said to be coming into the field.

In chemical composition both Indian and Java *kapok* are similar and contain 61—64 per cent. of cellulose (on dry fibre) [ANON., 1910. *Bull. Imp. Inst.* 8: 9 and DUNSTAN, W. R., 1909. Imperial Institute Selected Reports from Scientific and Technical Departments. I. Fibres. Colonial Reports—Misc. No. 58]. It was

Sample Tested.		Weight required to sink a bag containing 4 oz. of the floss in fresh water.							Calculated weight supported by 24 oz. of floss after 24 hours' immersion with 15 lb. of iron attached.
		A. immediately after immersion.	B. After 24 hours in water with 40 oz. of iron attached.	Weight of water absorbed after Experiment B.	C. After rough treatment following Experiment B.	Weight of water absorbed after Experiment C.	D. After rough treatment and 44 hours' further immersion with 40 oz. of iron attached.	Weight of water absorbed after Experiment D.	
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Eriodendron anfractuosum;									
Commercial Java *kapok*	Exp. (1)	83	87*		70	—	68*		32·6
	" (2)	82	91*	3·0	52		63*	22·4	34·1
Togoland *kapok*		73	73	—	56	—	49	—	29·3
Bombax sp. Indian *kapok* (*i*) (a) Machine cleaned in India.	Exp. (1)	99	97		77	—	70	—	36·4
	" (2)	107	107	3·0	52	—	58*	28·3	40·1
Calotropis sp. *Akund* floss (*ii*) (a) Machine cleaned in India.	Exp. (1)	80	69	14	12	44	(Sank with less than 40 oz. of iron attached)	—	25·9
	" (2)	74	45	—	8	—		—	16·9

*These increase in buoyancy after immersion and after immersion following rough treatment are curious: they are not due to the canvas bag becoming impervious to air (owing to the water) and acting as an air vessel.

at one time believed that the impermeability of *kapok* fibre to water was due to a coating of fat or wax on its surface. This does not appear to be correct, because there is no correlation between the extractable fats and waxes, which are very variable, with the water resistance of the fibre. Moreover, the removal of the wax or fat does not cause any deterioration in its water repelling capacity.

The cell cavity of the single celled fibre of *kapok* is full of air and the thin cell walls consist of lignocellulose. The Imperial Institute (ANON., 1917. *Bull. Imp. Inst.*, 15: 126—127), suggests the following for determining the quality of the fibre.

(*i*) Observation of the degree of lignification by the phloroglucinol test. The best samples do not give any reaction with phloroglucinol, but the lower qualities give a reddish brown or even a magenta red coloration, typical of lignocellulose.

(*ii*) Microscopic measurement of the diameters of the fibres. The more uniform the diameter, the higher is the quality.

(*iii*) Floating the fibre on the surface of aqueous alcohol of sp. gr. 0.928 and determining the relative ratio of wetting and sinking of the different samples.

The ash content of Indian *kapok* is another distinguishing feature. Some commercial samples show as high as 4.4 per cent. of ash, but a properly cleaned sample contains 2.7 per cent. ash whereas Java *kapok* contains 1.3 per cent.

ADULTERATION

Indian *kapok* is some times adulterated with *akund* (*Calotropis procera*) floss, and occasionally with *Calotropis gigantea*. These flosses are similar in appearance and properties to *kapok*. They are of cream colour, soft and resilient and possess a brilliant gloss. They are also similar in chemical composition, containing about 64 to 69 per cent. of cellulose. These fibres, however, are longer and thicker, and are not as resilient as either Java or Indian *kapok*.

Adulteration with these flosses can easily be detected by microscopic examination. The characteristics of these flosses as compared to those of Indian and Java *kapok*, were determined in the Wood Technology Section of this Institute and are given in the following table:

Table Showing Important Features of Indian "Kapok" and Allied Fibres

No.	NAME.	Fibre wall thickness.	Lumen.	Tip of the fibre.	Base of the fibre.	Fibre length in inches.	Fibre diameter in inches.	Phloroglucin reaction.	Iodine and Sulphuric acid reaction
1	*Calotropis gigantea* ..	thin	widest	narrow for a long distance whiplike	club-shaped, or concave	1·4 to 1·8	·0018 to ·0026	nil	violet
2	*Calotropis procera** ..	thin	medium	narrow for the most part	transverse	1·2 to 1·6	·0012 to ·0018	nil	violet
3	*Eriodendron anfractuosum* ..	thick	medium	gradual or abrupt	suddenly narrow rather rounded in outline	0·6 to 1·0	·0006 to ·0012	nil to brownish	yellow
4	*Bombax malabaricum* ..	thin to thick	narrow	pointed	club-shaped with reticulate markings	0·7 to 1·1	·0006 to ·0013	nil to brownish	violet

*Sometimes spiral coils have been noticed around the fibres.

Calotropis fibres, as will be evident from the tests made by the Imperial Institute given before, are fairly buoyant and are almost equal to *kapok* in weight bearing capacity; but their main defect is that they are not so water repellant. They get quickly water-logged and cannot stand rough usage; hence it is that, when used as adulterants, they take away much from the value of Indian *kapok*. The Board of Trade, England, consequently has enjoined that Indian *kapok* meant for use in life-belts etc., should be absolutely free from adulteration with *Calotropis* floss.

HARVESTING, CLEANING, AND PREPARING FOR THE MARKET

The superiority of Java *kapok* rests primarily in the care with which the floss is harvested, graded and cleaned for the market. The floss is usually divided into four grades (*i*) *Superior* or *Extra*, containing less than 0.5% of seed. (*ii*) *Prime* containing not more than 2% of seed, (*iii*) *Fair average* containing $3\frac{1}{2}\%$ or less of seeds and (*iv*) *Damaged*. The low ash content of the floss (1.3%) is evidence of the care with which it is cleaned. The operations may be described as follows:—

(*i*) Full ripe pods, brown, shrunk and deeply fretted with wrinkles, are gathered from the tree by a small hook knife attached to a long pole. Immature pods are never gathered as the extraction of the floss is difficult and there is loss in quality due to discolouration.

(*ii*) The pods are dried in the sun and the segments opened by one or two strokes of a mallet. The floss is scooped out and dried in the sun. Grading is done at this stage, pure white being collected separately. Both the shells and the placenta which divide the segments are removed.

(*iii*) The segments are then spread on a platform for beating. This may be done in large wooden cases ($8' \times 3' \times 18''$) with a false bottom of wire netting ($\frac{1}{4}''$ mesh) on which the segments of *kapok* are spread to a depth of 4 to 6 inches. The fibre is at first rubbed by hand and then beaten with sticks. After beating for a few minutes, the top layers are removed and put on to another platform and given a second light beating to remove any remaining seeds.

(ANON., 1922. Trop. Agr. 59: 341-342). Machines are now largely used in Java for large scale cleaning. The machines usually employed consist of a horizontal chamber with perforated bottom. The floss is beaten up by a series of blades attached to a revolving shaft. These blades revolve close against the blades fixed to the sides of the chamber and the blades are so arranged that the floss moves along to the end of the chamber, from whence it is blown by a current of air into the receiving chamber. For large scale operations, Bley machines, which are capable of cleaning 500 lbs. of floss per hour, are used.

(*iv*) The cleaned floss is pressed into bales for export. Too much pressure (exceeding 140 lbs. per square inch) is avoided, specially in the case of the finest floss, to retain the elasticity of the fibre.

In Java the *kapok* is generally collected from trees grown in plantation hence both harvesting and cleaning can be done under controlled conditions, but in India *Bombax* floss is mainly collected from trees which are scattered, occurring both in the forest and in the rural areas, there being only a few plantations (Gorakhpur, U.P., Coorg and Assam). The floss is collected by villagers and forest lease holders, who generally do not pay sufficient attention to collection and grading. Moreover, *Bombax* being a big tree, the pods are usually collected when they ripen and fall to the ground. The floss thus collected passes through several hands before it reaches the exporter, who then prepares it for the market. Much of the adulteration with inferior floss like *akund* (*Calotropis*) possibly takes place when the *kapok* passes through the hands of middle-men. Excepting the machine cleaned Indian *kapok*, the rest contains a large proportion of impurities consisting of fine sand, seeds and portions of pods and placenta, etc. It is not uncommon to find Indian *Kapok* containing 5% or more of seeds. This will have to be carefully guarded against to establish the reputation of the Indian floss in the foreign market. Both the quality and reputation of *Bombax* floss would considerably improve, if the methods of collection and cleaning followed in Java are adopted in India.

Bombax is a much bigger tree than *Ceiba* which yields the Java *kapok*, hence the yield per tree is much higher. A seven to ten

years old *Ceiba*, which is considered to be a full bearing tree, yields 500 pods or about 5 lbs. of floss, whereas a full bearing *Bombax* yields 12 to 16 lbs. of floss free of seeds.

OUTTURN AND TRADE

Indian *kapok*, which had always been considered in the past, as inferior to Java *kapok* was, none the less, imported into the United Kingdom and other foreign countries, mainly for stuffing pillows, cushions, etc. It was in 1921-22 that the Board of Trade, England, gave permission to the use of Indian *kapok* in the manufacture of life-belts, and other life-saving devices. But 1921 and subsequent years were the period of boom in trade, following the last World War. It is, therefore, difficult to say if the increase in trade in 1923-24 was the result of the increase in demand for Indian *kapok* in making life-saving devices or of the general boom in trade. Even at this peak of trade in Indian *kapok*, the total volume of trade was only a fraction of that in Java *kapok*. Whereas India exported only 34,000 cwts. of *kapok* to all countries, Java and Madura exported 300,000 cwt. and another 20,000 cwt. were exported from the outer possessions of Netherland East Indies, mainly to Netherland. (ANON., 1926. *Bull. Imp. Inst.*, 24: 18-36).

A decline in trade in Indian *kapok*, which fell to about 23,000 cwts. in 1932-33, followed the general slump. Since then the export trade has improved and has become more or less stabilised, but the prices have fallen even below the level of prices prevailing in the slump period of 1932-33. The table taken from the Annual Statement of the Sea-borne Trade of British India, shows the trend of the export trade in Indian *kapok* (See appendix).

In India, the last closing price of double machine-cleaned *kapok* for the year 1940 was Rs. 21.17 per cwt. and this has since risen to Rs. 50 in 1942. This abnormal rise in prices is possibly due to the stoppage of the supply of Java *kapok*. No figures are available of the demand of Indian *kapok* for normal home use, but it must be big.

It is not possible to form any estimate as to how much *kapok* India is capable of producing at the present moment. Since

Bombax occurs widely scattered both in rural and forest areas, it is doubtful if the whole of the yield of floss is collected. It is very likely that a larger collection is made when prices are attractive and that much of it is left uncollected when prices fall. Every effort should, therefore, be made to collect all the available floss to meet the demand. *Bombax* is a fast-growing tree and its timber is much in demand for making packing cases, match boxes and match splints, etc., hence there are additional and stronger reasons, for starting plantations. Even if the demand for floss falls in the future, the demand for the timber will still continue and plantations are unlikely to prove a financial loss. If advantage is taken of the present heavy demand and superior quality *kapok* is put on the market, there is no reason why the Indian product should not capture and retain the market formerly occupied by the Java product. Detailed information about cultivation and production of *Bombax* crop are given in "A Note on Semal (*Bombax malabaricum* D.C.)." [JAGADAMBA PRASAD, 1941, *Indian Forest Bulletin* [n.s.] (*Silviculture*), No. 107: iv + 15 3 pls. (As. 0-14-0). Manager of Publications, Delhi.]

APPENDIX

Export Trade in Indian "Kapok"

Country of export.	1914-15 Quantity in cwts.	1914-15 Value in Rs.	1914-15 Average price per cwt.	1923-24 Quantity in cwts.	1923-24 Value in Rs.	1923-24 Average price per cwt.
British Empire	6,917	2,07,796	30·0	12,415	7,37,052	59·4
Other foreign countries ..	9,106	2,25,34	24·7	21,421	13,02,925	60·8
Total for all countries ..	16,023	4,33,030	27·35	33,836	20,39,977	60·1

Country of export.	1932-33 Quantity in cwts.	1932-33 Value in Rs.	1932-33 Average price per cwt.	1938-39 Quantity in cwts.	1938-39 Value in Rs.	1938-39 Average price per cwt.
British Empire	6,491	1,94,849	30·0	16,360	4,05,491	24·2
Other foreign countries ..	15,822	4,42,783	26·3	18,755	4,29,790	22·9
Total for all countries ..	23,313	6,37,632	28·15	35,115	8,35,281	23·55

1939-40

Country of export.	Quantity in cwt.	Value in Rs.	Average price per cwt.
British Empire ..	20,153	5,41,931	26·9
Other foreign countries ..	9,962	2,59,365	26·0
Total for all countries ..	30,115	8,01,296	26·45

EXTRACTS

DRY NAPIER GRASS

BY G. M. BAPAT, M.Ag.,

Superintendent, Dry Farming Research Station, Sholapur

It is computed that nearly 40 per cent. of the cultivated area in the Sholapur district has undergone such serious erosion that it has become unfit for growing *rabi* crops. The weather conditions of this tract are also uncertain that two seasons seldom resemble each other in a period of ten years. Due to the peculiar nature of the rainfall and topographical features and slope of the land, crops usually fail on this type of soil as a result of annual erosion. The average depth of soil is only five inches and the soil has no capacity to store rain water. This class of soil is capable only of yielding some *kharif* crops, provided there are sufficient early or *kharif* rains. Even though *jowar* has been grown on this type of soil by dry farming methods during the last five years, the yield has been extremelv poor. Nevertheless, such soils cannot be neglected as they form a large portion of the total cultivated area.

Trials of dry Napier grass therefore were undertaken to find out better use of such eroded lands. This grass has been known to grow luxuriously under irrigation as well as under dry conditions and is considered to be very good for fodder, both green and dry. On the suggestion of the Director of Agriculture, Bombay, this grass was first tried at the Dry Farming Research Station at Sholapur in 1939. The grass has been under trial for two years and the following are the details of the two years' work.

Raising seedlings.—Half a pound of seed was obtained from the Director of Agriculture, Mysore. Seeds were sown on a properly prepared seedbed similar to that for tobacco seedlings. The seed was sown in the middle of June and the seedbed was watered in June and July several times with a watering can. Germination was early and satisfactory. A highly eroded plot of *mal* land measuring 8.5 *gunthas* was chosen and was ploughed with a light iron plough 4 in deep on 1st June, 1939. Two harrowings were given, one at the end of June and the other in the month of July in order to break the clods and keep down the weeds.

The transplanting had to be postponed to the middle of August, owing to absence of sufficient rain in July. When the land became fairly moist in the month of August, the seedlings were transplanted. The distance between rows was kept three feet and that between plants one foot. Two seedlings were transplanted at each dibble. The rows were across the slope and more or less along contour lines. The transplanted seedlings got established in a week's time. The season of 1939 was one of the driest in recent years. The total rainfall at the Sholapur Farm from June, 1939, to January, 1940, amounted only 13.37 inches. The seedlings made good growth under the available rainfall conditions at the Sholapur Farm.

Cuttings of Napier Grass.—Three cuttings were taken when the grass was in inflorescence, once on 17th October, again on 3rd November and the last on 17th November. The height was about three feet each time. The green grass obtained in three cuttings amounted to 1,373 lb. per acre, while the total dry matter produced amounted to 262 lb. per acre, as against the average of 190 lb. of dry matter that was gathered in *rabi* crops of *jowar* on this piece of land. In view of the poor nature of the soil and the driest season, the yield of Napier grass in 1939 was considered fairly satisfactory. After the last cutting, the stubbles had to tide over six months, from January to the end of May, the hottest and the driest period at Sholapur.

The Napier grass began to sprout after the rains as expected in June, 1940. There were some gaps due to the death of a few plants. The gaps were filled on 27th June, 1940, from fresh seedlings raised in that season. The rainfall from June, 1940, to January, 1941, was 24.84 inches.

Run-off and Erosions.—It has been pointed out that the Napier grass was planted at right angles to the slope. The rainfall in 1940 was entirely different from that of 1939 which was the driest year. There was a heavy rainfall amounting to 5.88 inches on 11th August, 1940. The rain started in the evening at 7 and practically it poured through the whole night. The Napier grass could stand the heavy shower so very well and could so effectively control erosion and run-off from this plot which used to be annually eroded heavily,

that no gulley was formed anywhere. The bottom *bund* and the waste-weir at the end of the plot remained intact. This control of run-off and soil erosion is one of the greatest advantages of the standing crop of Napier grass.

The grass from the standing plot flourished. The height was moderate, being three feet. In all four cuttings were taken till the end of November. The plot received only four interculturings during the season.

TABLE I

Yields of Napier grass in lb. at Sholapur

Year.	Actual areas in *gunthas.*	Actual yield green.	Yield per acre green.	Yield per acre dry.	Rainfall.
1939-40 ..	8·5	292·0	1,373·0	362·0	13·37
1940-41 ..	8·5	805·0	3,783·0	1,109·0	24·84

Table I shows the details of the two years' results. Yields of the same plot for *jowar* during the previous four years are given for comparison (Table II).

TABLE II

Yield of "jowar" grain and straw for the previous four seasons from the same plot in lb. per acre

Year.	Dry matter.	Rainfall.
1935-36	107	28·05
1936-37	329	14·91
1937-38	73	27·87
1938-39	234	37·87

From the table it will be seen that this type of Napier grass can be used successfully in dry tracts like Sholapur on a soil which has become highly eroded and which is not capable of growing any *rabi* crops in the majority of seasons. The grass is much relished by the cattle and can be fed at any time. The analytical figures indicate that Napier grass is richer in proteids as compared with the *rabi jowar* and compares favourably in other constituents. The only weak point about this grass seems to be its shallow root system. The plants are liable to be pulled out by the cattle if the grass is grazed on the plot. It has to be cut and used for stall feeding.—*"Indian Farming", Vol. III, No. 11, dated November, 1942.*

HOW TO INCREASE FODDER SUPPLIES IN THE LOW HILLS, PUNJAB

BY N. P. MOHAN, M.B.E., I.F.S.,

Silviculturist, Punjab

Foreword.—The prevention of soil erosion throughout the hills and the *barani* tracts of the Punjab is one of the most difficult problems with which Government is faced. The first step taken is the closure to grazing in rotation of the *shamilat*. The increase in grass is phenomenal and brings much profit to the *zamindars* as will be seen from Mr. Mohan's very interesting pamphlet.

—*Sir Harold Glover, Chief Conservator of Forests, Punjab.*

Introduction.—Owing to the exigencies of the war situation, the need of increasing food and fodder supplies has assumed greatly increased importance. Transport conditions may produce difficulties in areas which normally import food and fodder. Increased production is, therefore, imperative. In the present emergency the best service that this province can render is to increase the production of food and fodder to the utmost extent possible. This publication explains various devices for increasing grass supplies.

Closure of an area.—If cattle are kept out of an area in the hills, a remarkable recovery in vegetation takes place and a tremendous increase in grass follows. Areas which normally produce little or no grass, principally on account of overgrazing, start yielding considerable quantities in the very first year and the yield goes on increasing from year to year due to natural re-seeding till the maximum is attained generally in three or four years. There is a spectacular increase in grass consequent upon simple closure. Such is the recuperative power of the soil.

It is not at all necessary to convert a closed area into a sacred shrine where neither man nor beast can be permitted, the grass can be cut at the most favourable time, or when it is most wanted, and stall-fed to the cattle. The chemical analysis of grasses collected from Nurpur Research Station in Kangra District, has shown that the nutritive value of a grass is at its maximum during the first stage of growth. It continues to be a maintenance ration even during the second stage of growth. Later on with the exception of a few grasses which have a protein content of about 4 per cent. the rest are non-maintenance rations.

Note.—Six inch high grass represents the first stage, the second is the milk stage when the seed is in a soft succulent condition, the subsequent stages are represented by ripe seed or when the grass is in a condition resembling hay.

Up to the milk stage, therefore, grass can be cut (and cut repeatedly) and provides a first class ration. It is only when it becomes mature that its nutritive value becomes low.

A closed area is frequently invaded by bushes and shrubs or if they were already present, they increase both in size and number and thus reduce the grass producing area. They should be kept within proper limits by selective cutting back. They and scattered trees, if any, should not be completely removed as they help to bind and conserve the soil by their deeper root system.

Contour trenching and watbandi.—Results of closure can be greatly improved if the area is contour trenched. Contour trenching is not advised as a universal method. It undoubtedly increases the output of grass, particularly when it is accompanied by sowings on the berms; but it is a fairly expensive method (Rs. 5 per acre or even more) and should, therefore, be confined to areas of scanty rainfall where vegetation including grass is almost entirely absent, *e.g.*, the Salt Range and the Attock district. A contour trench is a trench made along the contour. As its name implies, it has no slope. Water cannot flow in it. It is a sort of long trough. When full, it may overflow, but otherwise rain water is all imprisoned by series of contour trenches and made available to the soil which in turn feeds the plants. Contour trenches are generally 1 foot deep and 2 feet wide and the distance between them varies according to the slope. The smaller the slope, the greater is the distance between them.

Contour trenching is possible only on sloping land. If the area is level, it is divided into fields of convenient size and separated from one another by ridges 6 inches to 2 feet high depending on the rainfall. These ridges convert each field into a shallow basin which holds the rain water for use by the plants. This is *watbandi*, a method to be used in level areas or on very gentle slopes to increase fodder supplies.

Sowings.—The grass yield can be further increased if closure is supplemented by sowings. Sowing grass is a very simple operation. It consists in just scattering the seed when the ground is moist after a shower of rain in summer or sowing seed on the berms of trenches from where it spreads naturally later on. (*Sorghum halpense* is planted on the berms of trenches.) The following figures

collected from Nurpur Experimental Station of Silvicultural Research Division show the yields when all these operations are simultaneously carried out:

Serial No.	Name of grass.	CALCULATED YIELD IN MAUNDS PER ACRE. ONLY ONE CUT.				
		1937.	1938.	1939.	1940.	1941.
1	Mixture of *dhaulu*, allied species of *palwan* and *murmura*	..	27	66	68	69
2	Mixture of *khabbal*, allied species of *palwan* and *murmura*	29	31	46	49	30
3	Mixture of *palwan* and *murmura* ..	33	58	121	112	100
4	*Palwan*	..	..	12	55	56
5	Mixture of *lambu* and *murmura* ..	33	79	108	129	106
6	Mixture of *murmura*, allied species of *palwan* and *lambu*	..	48	81	75	104
7	Mixture of *dhaman, palwan, dhaula* and *lambu*	20	26	43	34	30
8	Mixture of *murmura* and *palwan* ..	28	29	94	104	112
9	Mixture of six grasses	29	33	53	60	73
10	Mixture of four grasses	..	34	79	63	70
11	Mixture of *Sorghum halpense*, allied species, of *palwan* and *murmara*	..	57	110	97	114

In the different fields at Nurpur, one species of grass was originally attempted to be cultivated but others have come in naturally and now almost all the fields have a mixed crop. The rise in yield in almost all cases as compared with the first two years is spectacular. Closure and resowing are within the means of any and every one. They only require labour, enthusiasm and will to do the job.

Grass silage.—It is a matter of common knowledge that grass production is greatest during the rainy season and there is acute shortage during the rest of the year. This is the inevitable result of the uneven distribution of rainfall during the year. Storage of

grass is, therefore, necessary to tide over periods of shortage. Grass can be stored either as hay or as silage. Hay supplies the roughage and the grass silage the materials necessary for the production of milk and growth. Silage is a substitute for fresh green fodder. As the silage contains natural moisture, juices and vitamins, it promotes the health of animals and is more digestible by animals than dry fodder. Drying and storing of grass are well known but not the siloing of grass. Experience in Central Provinces has shown that the easiest method of making silage grass is by means of silo pits; and they are worth trying in the Punjab.

The site of the pits should be chosen according to the source of supply of grass and the centre of consumption of silage grass. The site should be such that the water cannot rise in it during rains. Firm ground is desirable. A convenient size of the pit is 10 feet long, 5 feet deep and 6 feet wide. It is convenient to have a battery of such pits.

Grass must be cut green and before the flower heads ripen. After cutting, the grass should go at once to the pit and not be permitted to lie on the ground. The pits should be filled with grass steadily to begin with and more rapidly later. The lower layers must be filled evenly and should be allowed naturally to heat up. *Pulas* of grass should be made to lie lengthwise in the pit. Material must be continually trampled while the filling goes on a little water being occasionally added to make up for the loss by evaporation. The addition of a few pounds of salt makes the silage more palatable. In filling the pits, care should be taken to see that centre 3′—4′ are higher than the sides, so that on settling the grass presses tightly against the sides of the pit. Every precaution should be taken to see that air and outside moisture are kept out. Packing must be very thorough.

Two to three feet layer of earth is put on the top and on the side and rammed well down. Sides and top of the earth are covered by bamboo screens to prevent spoiling of contents by loose earth. Silage will settle in about ten days when a rough thatch should be put on top to keep out rain. The top should be kept well pressed down by stones, logs, etc.

The pits keep their contents in a satisfactory condition for about 8 months. Sinking of the top takes place gradually and top covering may need attention from time to time.

At the time of the opening, the top layer of the earth is removed by sections of sufficient width to permit easy removal of silage and to minimise exposure of the rest of the silage in the pit. Any mouldy silage near the top, etc., should be first removed and thrown away. Silage on removal should be dark brown in colour, slightly warm and moist with somewhat unpleasant tobacco-like smell. Silage should be removed only when the cattle are to be fed. Cattle are at first reluctant to take to silo but they soon overcome their prejudice against a new diet.

A PLEA FOR PROFESSIONAL COURAGE

BY HARRIS COLLINGWOOD,

National Lumber Manufacturers' Association

As foresters, we may be pardoned a certain satisfaction and pride in our profession and in responsibilities we have assumed for protecting, managing, harvesting, utilizing, and restoring one of the world's vital resources. In short, as professional foresters, we would assure the continuous growth of forests for the production of forest crops.

That we recognize the complex ecology of the forest and its manifold contributions toward water storage and water power, wild life and recreation, beauty, and inspiration, in no way lessens the basic responsibility for continuous forest growth.

We who are gathered here are fortunate in having been given special responsibilities. But the country, as a whole, is reluctant to entrust the administration of all forests to professional foresters. Counting all American forest lands, including those in the several forms of private ownership, the federal lands and those under the protection or administration of the states, counties, and municipalities, the guiding hands of professional foresters are affecting scarcely more than one-half the total forest area.

One is reminded of a subordinate who was greeted by his pastor as he worked in his garden. "Isn't it wonderful," remarked the minister, "what wonders can be accomplished when we work with God?" The man with the hoe wiped the sweat from his forehead and replied, "But ya oughta seen this place a year ago when only God worked on it."

For centuries before Ponce de Leon searched this peninsula for the waters of everlasting youth and thereafter for more than four hundred years, God did so well with American forests that many people are still satisfied that no guiding professional forester is needed. This may be because the public has been slow to distinguish between a woodsman and a forester. Early foresters were in truth woodsmen and all agree that one is a better forester for being a woodsman. Similarly, early surgery was a function of barbers, but the range of modern science and technique has led the surgeon so far beyond the barber that their relationship is fast fading into history. So it is with modern forestry the intricate ramifications of which include botany, chemistry, geology, and trigonometry, even ecology, pathology, entomology, and engineering, all so far advanced from simple woodsmanship that no individual forester pretends to be master of them all.

We take pride that professional foresters have an increasing part in the administration of privately-owned forest lands, but their influence is still too meagre. Fortunately, with a few exceptions, state forest divisions are headed by well-qualified professional men, but too often their staffs comprise a heavy proportion of local politicians who are not even good woodsmen. Created almost overnight by presidential decree, our national forests presented an administrative task which exceeded the available staff of professional foresters. As a result there was a beginning period when much responsibility fell on forest rangers who had graduated from the fields of cow punching and mining. True to American tradition many of those men rose to key positions, where they have contributed to the effective administration of the Forest Service, as well as to the glory of the profession. With full respect to the self-made man, we are all proud that our national forests are now largely administered by professional foresters. The same may be said of our

national parks, the forests of the O. & C. lands in western Oregon and the Indian forests.

The essential point, however, is that so large a portion of American forests are without the guiding administration of professional foresters, and that the public has been slow to accept forestry as a profession comparable with engineering and architecture. Perhaps, these are some of the growing pains of a profession which only a year ago celebrated its fortieth anniversary. It is a situation, however, which we should view without blinking and fairly. In the relative rush of responsibilities which we foresters have been called upon to assume, we may, perhaps, have brought criticism upon ourselves. Taken as a whole, however, the public has been generous to this new profession. During the past forty years, some 10,000 men and a few women have been graduated from forestry schools established across the length and breadth of the United States. Some of these schools have been inadequately financed and the staffs lacked the leadership needed in so vital a profession. Nevertheless, approximately 6,500 forestry school graduates are reported as gainfully employed in forestry work. According to Henry Clepper, our executive secretary, there are 2,800 in the several federal bureaus and agencies, 500 in state forestry, and 650 employed by the forest products industries. All this is an encouraging record, but when considered in the light of the social, aesthetic and economic responsibilities it offers nothing to brag about.

The history of our profession reveals, in the belief of many a disproportionate amount of energy devoted toward evangelism and propaganda rather than toward the economic responsibilities for satisfactory continuous management of forest lands. Perhaps we have been too willing to strive to grow trees for their beauty rather than for their utility. The result has been that we may have been inclined to exaggerate our national forestry ills, and urge solutions before the forestry problems of smaller areas in public and private ownership had been satisfactorily solved.

Can it be that the public has grown skeptical of a profession whose forty years' record is so largely one of unfulfilled alarms? The timber famine that has been periodically prophesied since the first of the century has progressively receded. As recently as 1924 the

word went over the country that the lumber industry of the South would be cut out and completely exhausted within ten or fifteen years. Contrary to official prognostications the South, with 44 per cent. of the commercial forest area, continues to be a major source of American lumber. The cut-over South has an increasing number of forest properties where protection, silviculture, and utilization are being more nearly solved than any place in America—if not in the entire world. The prophecies of 1924 and earlier were carefully considered and conscientiously announced. That they proved to be mistaken should be a signal for the profession responsible for their distribution to realign its thinking. Regardless of experience and the evidence which meets the eye of any one who travels over the South—regardless even of the figures revealed in the forest survey, professional foresters continue to warn of the danger which will follow the removal of timber here and of overmature virgin timber in the Pacific North-West. The belief is expressed that national welfare demands state and federal regulation of the operations of all forest land owners. To this are added dire prophecies that our national prosperity will be threatened unless more land is progressively removed from private, tax-paying ownership and placed under public administration.

This question of regulation, as against the still unfilled functions of protection, education and research, is occupying too much of the energies and activities of our professional leaders. One is reminded of the philosophers of the middle ages who argued heatedly over the number of angels who might occupy the point of a needle.

Meanwhile, lumbermen and timberland owners motivated by laws of economics and continued faith in the national American policy of free enterprise are attempting to put their properties on a basis of continuous productivity. Their conception of free enterprise has assumed a self-disciplined, scientific form. With a realization of responsibility for the preservation of the soil and for the continuance of existing, desirable social structures which this professional group cannot afford to ignore—they are putting their forest lands under management for continuous production for forest crops. For simplicity they call the forest areas tree farms. The result, however, is no different than as if they were called sustained yield

forests. Professional foresters on the staffs of these lumber companies occupy positions comparable to those of engineers, accountants and architects. They are working out the tree-growing programme within the limits of the economic laws of supply and demand. Their efforts are confined only by the requirements of a financial ledger on which only black ink is desired. The boards of directors of the several companies who employ these foresters are motivated by a definite social responsibility for the continuance of the communities dependent upon their mills and forests, and for the continuous employment of men who have helped build their industry.

With such progress and with the future which lies ahead of this profession, foresters must have greater faith in their ability to economically produce lumber, and courage to push out beyond the limits of their horizons. More than that we must have more faith in one another. Professional foresters who believe that continuous production of forest crops can be attained only through the state regulation, dictated and dominated from a central federal bureau need faith in the desires and expressed intentions of an industry responsible for paying wages to several hundred thousand workers. This is the industry whose leaders have publicly stated, "We think that the establishment of forestry practices suited to continuous forest production is an obligation of forest owners and of the industries using forest products."

Professional foresters who believe that forestry can best be accomplished under the stimulus of America's traditional policy of free enterprise and who believe that permanent production of timber crops is a natural corollary of enlightened self-interest need faith also in those professional foresters who believe in the necessity of federal and state regulation. More than faith, they need to extend sympathy to their brothers whose efforts are based so largely on fears—fear of a timber shortage, fear that some considerable portion of the forest owners and operators will lag behind the forest leaders, fear that there will be a destructive hiatus between the states with good forest practices and those whose citizens are bent on forest destruction through carelessness and selfishness. Fear never did anything for a man or a profession other than to encourage them to run away from their responsibilities and their opportunities.

We foresters, individually and collectively, need courage and mutual faith in the unity of purpose of all professional foresters to the end that all forests may be continuously productive. If we will work to that end stimulated by constructive ideas, but without too much friction concerning the means of achieving continuous forest production, forestry can occupy the place in American economics that it deserves.

We have been, and are in danger of continuing to be, a profession of little faith—afraid of what may lurk beyond the furthest hills. There may be real opportunities beyond and without fear of our horizons we must push them out. It is our job as foresters to deal with facts. With facts, and with faith in the results of research, we can dispel the bugaboo of possible timber famine, and help the public realize the wealth that is in the forest. Such was the contribution of men like Austin Cary, who talked commonsense forestry to the timber land owners of the South and whose footprints are now green with growing trees, and of Herty who pioneered in the manufacture of pulp and paper from southern pines. As a result young pines have acquired a recognized value and the attitude of most local people toward woods' fires is fast changing to make them active co-operators of foresters and forest owners.

Think of it! Only 38 years ago yesterday a little woman in Dayton, Ohio, received a telegram from her brothers, Orville and Wilbur Wright, who were then down in the windy sand banks of the North Carolina Coast. She hurried to the editor of the newspaper and read him, "We have actually flown 120 feet. We will be home for Christmas." The city editor replied, "Well, well, isn't it nice they will be home for Christmas?" And there was no space for the news item that might have foreshadowed the attack on Pearl Harbour.

American life has changed more in the past forty years than in any time during the history of this country, yet the forestry profession still thinks in terms of scarcity. Wood is one of our most important resources, yet as we continue to argue questions of regulations, we are in danger of missing the boat by too much talking, too little action, and too little courage.

—*"Journal of Forestry," Vol. 40, No. 2, dated February, 1942.*

INDIAN FORESTER

MAY, 1943

SEEDING OF *ANOGEISSUS LATIFOLIA*.

BY JAGDAMBA PRASAD, B.Sc., LL.B., P.F.S.

Experimental Assistant Silviculturist, F.R.I., Dehra Dun

Economic Importance of Anogeissus latifolia.— *Anogeissus latifolia* is a species of importance in the economy of Indian villages that adjoin forests, in which it is found, as cart-axles and brake-poles of the wood are used by the less wealthy villagers instead of iron ones. In the case of a breakdown the wooden-axle cartman is more lucky than his wealthier brother for his replacement part is close at hand and needs only his own skill to make and put it in. In certain parts of the forests these men are allowed to fell a tree for replacing a broken axle free or at nominal rates of royalty.

But it is due to the great strength of this wood, especially in shock resistance, transverse strain and hardness that it has achieved a well-earned reputation as a substitute for ash and hickory for shafts, helves and tool handles, in the market. It has been estimated that normally at least 2,000,000 tool handles are required annually in India, so there is plenty of scope for expansion in the Indian trade. Formerly the wood was not over-popular with craftsmen, probably on account of the seasoning difficulties as it is difficult to air-season, but now that more is known about the method of its seasoning, it should not be difficult to market the wood for tool handles (1).

Locality of Occurrence.— The tree occurs principally in central and southern India, but is absent in Burma, eastern Bengal and Assam. It is most numerous between 74° and 84° east longitudes and the area in which it occurs may be taken as running roughly from Dehra Dun in the north through the Central Provinces to Tinnevelley in Madras and to Ceylon in the South. It grows at all altitudes between 200 and 4,000 feet on laterite and granite soil (2).

Natural reproduction.— The natural reproduction of this tree is not yet fully understood. As a rule the tree seeds abundantly every

year, but the fertility of the seed is usually very poor. This want of fertility of the seed does not accord with the fact that reproduction often springs up in dense masses on well-drained hill-sides. In the *Indian Forester* of 1907 (page 231) Pearson advanced a theory to explain this. Having noticed in the Panch Mahals (Bombay) that reproduction appeared in even-aged masses differing from each other by definite intervals of years, as determined by counting rings on cut seedlings and saplings, he ascertained that the years in which reproduction took place were those following on years of deficient rainfall. He surmised therefore that whereas under normal conditions the tree produces little or no fertile seed, the production of fertile seed is stimulated by years of drought. Troup remarked that this theory was well worth following up by fertility tests of seeds carried out annually for a series of years, including seasons of good and deficient rainfall (3).

F.R.I. Experiment on seeding.— Experiment No. 44 was accordingly designed by the Forest Research Institute, Dehra Dun, to determine whether a relation existed between the fertility of the seed of *Anogeissus latifolia* in successive years and weather conditions. Four typical (climbable) trees were selected at Mohand in the Saharanpur Forest Division, for the experiment, in 1928. Seeds were collected from the four trees in the first week of May and estimates of the quantity remaining on each tree were carefully prepared to arrive at the total seed crop from each tree. Samples of cleaned seed (3 ounces from the seed collected from each tree) were taken, graded by diameter classes and sown in four boxes (one for each tree) on 23rd July, 1928, for the usual germination tests in standard media consisting of equal parts of sand, garden soil and leaf mould.

This procedure has been continued for the 15 years ending 1942, with a few exceptions that follow. In 1932 trees Nos. 2 and 4 did not produce any seed. In 1937 also tree No. 2 did not yield a seed crop. In 1936 tree No. 1 was found girdled but alive. It produced about five times the average quantity of seed produced by the remaining three trees in that year. This tree No. 1 was still alive in 1937 but produced no seeds. In 1938 tree No. 1 died because of the girdling. In 1942 tree No. 2 was found felled and logged at the time of inspection. In 1934 all the four trees were found to have a good seed crop at the preliminary inspection in the second week of April, but

Fig. I

May, 1932

Seeding of Anogeissus latifolia
Expt. 44, seed tree No. 1, at Mohand, Saharanpur Division, U.P.

Fig. II

May, 1932

Seeding of Anogeissus latifolia
Expt. 44, seed tree No. 2, at Mohand, Saharanpur Division, U.P.

Fig. I

May, 1932

Seeding of Anogeissus latifolia

Expt. 44, seed tree No. 3, at Mohand, Saharanpur Division, U.P.

Fig. II

May, 1932

Seeding of Anogeissus latifolia

Expt. 44, seed tree No. 4, at Mohand, Saharanpur Division, U.P.

no seeds could be gathered as due to a severe hailstorm the entire crop was completely lost.

Description of the trees.— In 1932 photographs of the four trees of *Anogeissus latifolia* were taken (see plates 13 and 14). Trees Nos. 1 and 3 were recorded as (D) dominant and Nos. 2 and 4 as (d) dominated. The following are the diameters at b.h. of the trees:

Serial No. of trees.	Diameters at b. h. over-bark in inches.		
	1932	1942	Mean annual increment.
1.	14.4	..	..
2.	10.3	13	·27
3.	15.9	19	·31
4.	19.8	24	·42

Description of seed.— The small dry indehiscent fruits, crowded in globose heads, are 0.15-0.25 in. in diameter, compressed with a narrow wing on each side, yellowish brown and fairly hard (3). How remarkably accurate this figure given by Troup is, was seen from the 14 years' records of the F.R.I. experiment where the range of seed size was found to be from .1 to .25 in. in diameter. Troup states that the seeds weigh about 3,000—3,500 per ounce. The records of the F.R.I. experiment furnish figures from 48 independent seed weight tests, the average for which is found on calculation to amount to 3,850 $\pm$ 115 seeds per ounce.

No periodicity in seed crops.—Plants that give seed after intervals during which no seed is produced or if at all, is very scanty, are said to exhibit periodicity. This periodicity in seed production may be of two kinds, one of which is due to a natural process inherent in the species such as is found in species of bamboos, etc. The other is produced by external factors such as weather conditions. In the case of the seed crop from the trees of *Anogeissus latifolia* under observation from 1928 to 1942, there is no evidence of a periodicity in the total seed crop production. The average seed crop per tree is found to be 242.8 $\pm$ 54.0 ounces per year. The average yield of seed in no year is found to be outside the limits of thrice the standard deviation ($\pm$ 211).

Effect of drought on seed fertility.—The following table shows the rainfall in inches from June of the preceding year to May of the

indicated year, the average outturn of seed in ounces per tree and the average germinative capacity per 1,000 seeds.

	1928	1929	1930	1931	1932	1933	1935	1936	1937	1938	1939	1940	1941	1942
Rainfall in inches from 1st June of the preceding to 31st May of the year ..	51·41	34·10	39·44	49·47	43·38	84·38	54·84	34·52	85·43	59·51	44·13	65·87	43·25	46·79
Average outturn of seed in ounces per tree ..	86·5	340·5	360·0	69·5	19·0	365·5	291·1	242·5	148·0	491·0	800·0	67·0	162·0	200·0
Average germinative capacity per 1,000 seeds ..	12·2	46·2	43·3	17·6	7·1	4·3	7·7	0·5	2·2	8·7	6·0	4·4	4·7	5·6

The average rainfall amounted to 53.57 ± 4.04 for the 15 years from 1928 to 1942. Rainfall significantly in deficit occurred in the years 1929, 1930 and 1936. The average germinative capacity when averaged for the 14 years gives the figure 12.2 ± 3.86. Significantly superior figures are thus those of 1929 and 1930. This establishes the theory profounded by Pearson. In other words rainfall significantly in deficit from the average during 1st June to 31st May results in a significant increase in the germinative capacity of the seed of *Anogeissus latifolia*. The results of 1936 are, however, not in accord with this theory, but it is very probable that the girdling of one of the four trees in that year is responsible for the disparity and the theory thus remains unaffected by those figures.

REFERENCES

(1) TROTTER, H., 1941. *The Common Commercial timbers of India and their uses.* Manager of Publications, Delhi: Price Rs. 2: I—VI, I—IV, 1—234+11 pls.

(2) RODGER, A., 1913. Note on dhaura or bakli. *Forest Bulleiin* No. 21. Superintendent Government Pinting, India, Calcutta: Price As. 4 or 5d.: 1—15.

(3) TROUP, R. S., 1921. *The Silviculture of Indian trees*, Vol. II, Clarendon Press, Oxford: i—xi+337—783+i—iv.

SEPTEMBER OPERATIONS IN THE *KACHOS* IN SIND

By B. B. Wadhwani

Range Forest Officer, Jherruck (Sind)

Sind has the reputation of an arid tract. Its nomenclature as a desert is no exaggeration inasmuch as its average annual rainfall is no more than 5.6 inches. All life in Sind would be impossible but for the river Indus. Sind forests are therefore mostly situated along both the

banks of this river. The average rainfall by itself is insufficient for the subsistence of forest vegetation which lives on the annual river floods. With the commencement of the hot season when the snow on the Himalayas begins to melt, the level of the Indus starts rising. This rise becomes more noticeable by April, reaches its peak level by mid-August and falls to its winter level by mid-November. This period of rise and subsequent fall of the river is termed *Abkalani*.

Kacho is a Sindhi word. It is used as an adjective for soft, unstable, temporary. As a noun it is a technical term meaning river alluvial formation, so called because the permanence of such areas is always a matter of conjecture, depending upon the vagaries of river Indus.

Within some 400 miles of its delta the Indus keeps changing its course—eroding one bank and leaving corresponding area on the opposite bank. This takes place during the *Abkalani*. These new alluvial formations, which are noticeable only after the fall of the river, are termed *kachos*. These *kachos* are renamed *pakos* when later on the river recedes further and further and leaves fresh alluviums every year, in the progress of its recession, in front of the older ones. *Pako* is opposite of *kacho*.

The soil of *kachos* is an interesting study. It varies from pure sand to pure clay layers of varying depths on top, while the cross-section consists of strata of sand and clay or mixture thereof of different thicknesses. When the top layer consists of pure sand it is blown off by the winds and forms high dunes covering the better types of soils and the forest growth thereon, rendering these unproductive.

Topographically, the *kachos* are undulating. Sand-mounds and depressions are not infrequent. When the top layer consists of greater proportion of silt, it cracks on drying the crack depth being from 1 inch to about 3 feet. These cracks are called *phories* in Sindhi. This is more or less a common feature of the *kachos* in the first 2-3 years.

In the first year of formation the level of the *kachos* is low where water stands high; this renders it unfit for forest operations. Suitable portions are therefore sown up with mustard, oil seeds and pulses in lower Sind with the addition of *simco* in upper Sind. Broadcasting of these cereals is undertaken as soon as water leaves the area

and the ground is still very soft. In the second and subsequent years, if the area is still low, cereal cultivation is repeated. By this time the cracks generally close up when it is possible to plough the area and grow wheat and barley. The Forest Department realizes assessment from these cultivations which is anything between Rs. 2 and Rs. 5 per acre generally. Within 2-3 years the annual deposit raises the level of the ground sufficiently to warrant undertaking of forest operations.

The natural flora of the kachos.—After the annual fall of the river, such light seeds as of *Populas euphratica, Tamarisk* species and grasses of *Saccharum* varieties, which are water borne, are left on the ground which start germinating in various proportions. The grasses so long as they are young and succulent provide fodder for cattle. These grasses do not matter in the first two years but subsequently they become a great hindrance to *babul* (*Acacia arabica*) and all artificial efforts are made to put the grasses down. *Tamarisk*, in the first two years, acts as a nurse to *babul* against frost to which the latter species is very much susceptible. Advanced growth of *Tamarisk*, however, is a great obstacle in broadcasting, inasmuch as it precludes the men from touching more than a fringe of the *Tamarisk* area. Parallel lines 30 to 40 feet apart are then cut in such areas well in advance of the floods to enable the men to walk along these lines and broadcast seed in the intermediate *Tamarisk* strips. Where grasses take possession of the area, they expose it to fire incidence and consequent destruction of valuable growth. In older *kachos* where the top layer is sand and which have grown so high as to be beyond reach of the normal floods, *ak* (*Calatropis*) species covers the area with a sprinkling of *kandi* (*Prosopis spicigera*). *Ak* provides fodder for goats.

Afforestation operations carried out in kachos.—By about the last week of August the river floods start receding; immediately on this, broadcasting of *babul* (*Acacia arabica*) is undertaken in the *kachos* formed in previous years. Simultaneously, the broadcasting is done in such parts of the older *kachos* where the seed has failed to establish previously. The men wade through waist-deep water to scatter the seed with hands. Within about a week all the water has receded from the area, leaving a thin layer of silt over the broadcast

seed which has previously sunk slightly into the soft ground on account of its own weight also. The broadcasting period being very short, and the areas to be sown being very large, all the available help is mustered, so as to complete it in time. Boats are engaged to take the men and seed across deep waters. A week or so after the water has left the area, germination commences, continues for another week and is generally profuse but irregular. There may be patches very thickly germinated while there may be blanks. Very often it so happens that after broadcasting there has been thick silt deposit; this smothers the seed. Of course, an annual silt deposit is always to be expected in the *kachos* which may be anything from few inches to 2-3 feet and that is why particular care is taken to carry out broadcasting operations only when it is expected that the river water is definitely receding, otherwise if the water stands the area for more than a week after broadcasting, the seed has less chances of pushing through the heavy silt deposit. Silt deposit is the greatest where the flow of the river is the slowest.

By about the 15th September the ground is dry enough to allow men to walk along, and all the seed that had to germinate will have done so. Small blanks are then filled up with dibbles. This operation lasts for about a week or so and by this time the ground dries up further to withstand the weight of oxen. Large blanks are then drilled into. To the handle of an ordinary country plough, drawn by a pair of oxen, a wooden tube with a funnel-shaped mouth is tied; the man behind the plough goes on ploughing the area and simultaneously pouring *babul* seed into the funnel which falls into the furrows and gets slightly covered with the upturned earth. This method is cheap, quick and particularly adapted for augmenting broadcast sowings in the vast *kacho* areas, but cannot be employed in grassy or *Tamarisk* areas.

It is most desirable that all sowing operations are completed by about the 30th September, although due to labour and other difficulties these are delayed to mid-October. Seedlings from sowings after the 15th October are small and have less chances of surviving the coming cold weather and of escaping submersion by the next inundation. The winter minimum temperature is lower in *kacho* than in *pakos* and as such the toll taken by the frost is also heavier.

The reason for the scarcity of labour is that with the onset of *abkalani* the forests become breeding places of mosquitoes on account of which most of the cattle owners migrate. The mosquito and sand-fly trouble continues till the winter sets in. The forest cattle owners are the only source of labour for forest works in Sind.

As to the trying conditions under which these operations are carried out, I can do no better than quote the words of Mr. D. B. Sothers, I.F.S. (lately Conservator of Forests, Sind), in his article on "Riverain Forests in Sind, 1936—41", published in the *Indian Forester* of December 1941 (Vol. LXVII, No. 12, p. 642, concluding paragraph):

> "Regeneration works in India often have to be carried out under unpleasant conditions. In Sind they are as bad as can be met with anywhere. The work has to be done under the September sun when the river is falling. In addition to the heat the receding water leaves behind it a steamy atmosphere, swarms of biting insects and a ground the consistency of a sticky snipe bog. The staff have done well to carry out large-scale works under these conditions. So far they have received little thanks for what they have done; it is in consequence pleasant to be able to give their excellent work some extra publicity in this note."

It is very important that *kachos* are fully afforested as soon as possible after their formation, otherwise in course of time, with the annual silt deposit raising the ground level, areas which once had formed the very bed of the river, get beyond reach of the normal floods—the growth thereon then subsisting only on the sub-soil moisture and the scanty Sind rainfall.

In the later years, after the regeneration has established in the *kachos,* the usual cleaning, spacing and thinning operations are carried out which it is not the scope of this article to describe. Very often it so happens that with several years' efforts to afforest a *kacho,* and after the regeneration has survived, various adverse factors like frost, fire, drought, insects, animals, etc., the Indus takes fancy to erode it. Painful, as this sight may be, it is inevitable and we, Sind foresters, have learnt to take it as *fait accompli* and resign ourselves to it.

RAISING OF NEW *CHIL (PINUS LONGIFOLIA)* CROPS

By Fazl Mohammad Khan, I.F.S.

Summary.—Describes various operations under which new *chil* (*P. longifolia*) crops have been raised and conserved in thousands of acres of regeneration areas in *chil* forests of Murree, Kahuta (Rawalpindi) and Hamirpur (Kangra) hills.

Regeneration.—*Chil* regenerates under very varying conditions of soil and climate, but it does best in relatively open places with some lateral shade and clean ground. To produce these conditions in existing *chil* forests the most suitable system of management is that of shelterwood compartment coupled with burning of felling refuse and rubbish. This burning should be done under control during winter months; and it will facilitate the operation, if the rubbish is collected in small heaps scattered all over the area. Natural seeding occurs in the month of May and usually is sufficient to sow up the cleared area, but to make sure and to save time some broadcast hand sowing should also be done at the same time. Germination takes place early in the following rains and is generally profuse; and growth of seedlings is particularly fast in ashes and spots where burning has been severe; and if adverse factors do not intervene there would spring up a dense mass of regeneration. These adverse factors are:

(*i*) suppression by grasses and weeds, and

(*ii*) fires.

Tending of young chil crops.—To counteract or at least to minimise the ill effects of the adverse factors would constitute *tending*, and below are detailed the tending operations which have been found eminently helpful in preserving thousands of acres of new *chil* crops in the forests under regeneration.

(*i*) *To counteract suppression by grasses and weeds.*—Germination of *chil* seeds starts early in rains, and that is the time when grasses and weeds spring up too; but as the growth of weeds is far faster than that of the seedlings the latter get suppressed and damp off, the mortality being enormous. This suppression is in fact the principal cause of the failure of regeneration of which one reads so much in annual reports. As a remedy controlled grazing in regenera-

tion areas has produced excellent results. *The rule is to watch the progress of germination of chil seed during the first fortnight after the first monsoon rain in order to get an idea of the seedlings in the regeneration area. In a month's time after the first rainfall grasses will have formed a matting on the ground covering all chil seedlings, and this is the most critical stage of them, as with continued suppression they are bound to damp off. Light cattle grazing in the area at the time will be very helpful to uncover them as some grass will have been eaten up and some trampled down; but this grazing must be strictly controlled and the cattle must be kept on the move.* The process may be repeated whenever the danger of suppression of the seedlings by grasses becomes acute. No hard and fast rule can be laid down to govern the intensity of the grazing. It will depend on the discretion of the man in charge who must be an experienced Range Assistant in the early stages. After sometime the beat guards get the knack of it.

Caution.—It must be borne in mind always that grazing is an evil and is prescribed in this instance to counteract another evil, so that it should be strictly controlled and should be stopped the moment the matting of grass is broken sufficiently to permit the seedlings to be visible.

This object can be secured by grass cutting as well, but the grass cutters, in their carelessness or haste, are not likely to discriminate between grass and seedlings and are apt to cut both alike. Grass cutting should therefore not be permitted till the seedlings have grown well above the grasses.

(*ii*) *To minimise fire hazard.*—*Chil* forests can never be made immune from fires, and the more they are "protected" the worse is the damage when once a fire gets in. In the case of young, protected crops fire means the end of them once for all. It is therefore of the highest importance to devise means to minimise the fire hazard, and any contribution towards this end will be an achievement.

The obvious things to do to minimise the fire hazard are (*a*) to reduce the quantity of inflammable material in the area, (*b*) to make the new crops more or less fire-proof, and (*c*) to localise fire if one occurs.

(*a*) *Controlled grazing.*—When all rubbish has been burnt before seeding the only inflammable material in the regeneration area will be dead grasses and fallen pine needles. Grasses die in winter months, and early summer is the fire season. The interval between the two is the time to reduce the quantity of dead grasses, and this can best be done by letting in controlled grazing to eat up some grass and to trample down some. This should be repeated according to the requirements of individual areas.

(*b*) *Lopping.*—A *chil* seedling develops long needles (leaves) in the 3rd year generally, and lateral branches in the 4th year. These branches persist for years and generally droop downwards in early life, so that they get mixed with grasses. In such a position any ground fire will scale by means of these branches to the top of the seedling whatever its height, and cause irreparable damage. To remedy this evil its lower branches should be pruned off so that its crown loses contact with the ground and so escapes ground fires. Also pruning must not be so excessive as to impair the seedling's vitality. *The rule therefore is to prune off lower branches to half the height of the seedling till its bole has been cleaned to a height of at least 6 feet above ground.* The pruning must also be done flush with the stem to facilitate "healing". The operation is progressive and should be repeated year after year as the seedling grows till the desired height of clean bole has been obtained. Incidentally, this type of pruning has been noticed to stimulate height growth.

Where seedlings grow close together it is best to do an early cleaning in them at the same time in order to space them 3 feet apart more or less.

(*c*) *Inspection paths.*—To localise the fire if one gets into a *chil* regeneration area quick movement is necessary and for this purpose 2 ft. wide contour-paths are essential. These paths not only enable fire-fighting parties to move about quickly, but provide excellent bases for counter-firing in case of serious fires, and can be constructed at a cost of some Rs. 45 a mile if advantage is taken of moist ground after rainfall.

The final operation which should render a new crop of *chil* fire-proof as far as possible is controlled burning when the average

seedling is 8 ft. high so that at least 3 ft. of bole above ground has been cleared of branches. The idea is to get rid of any dead litter that may have accumulated on the ground in spite of regular controlled grazing. Fairly heavy grazing should be admitted in the crop for a week or ten days before firing to reduce the quantity of dead grass on the ground, as this will help to keep fire under control.

The above observations are based on years of experience in dealing with *chil* regeneration gained by trials in the *chil* forests of old Rawalpindi East and Beas Forest Division where *chil* regeneration has been obtained and conserved in thousands of acres of P.B.I. areas. Another factor which has contributed largely to the success achieved has been the co-operation of the local people whose confidence must be won by the local staff by giving up harassing practices.

EXTRACTS

FORESTRY IN THE COLONIES

BY SIR ALEXANDER RODGER, O.B.E.

In Vol. 20, No. 2, 1941, of the *Empire Forestry Journal* Professor Stebbing has recorded at considerable length and in logical fashion his meditations on the subject of Forestry in Africa, and the present writer has been led to wonder whether it would not be possible to extend such of his proposals as are found feasible to all the Colonies.

Twenty Colonial Dependencies, the number whose forestry is described in Part II of the late Professor Troup's last volume, *Colonial Forest Administration,* have a population of about fifty million and a forest area estimated at 600,000 square miles, about one-third of the total area. They extend from 90 degrees west to 180 degrees east longitude and, except Cyprus and Palestine, all lie near the Equator, so that it is not unreasonable to suggest that some sort of homogeneous or at any rate co-ordinated treatment should be employed in managing their forests.

In reviewing Professor Troup's book in the *Quarterly Journal of Forestry* for April 1941, the writer quoted from Chapter I: "There are few civilized countries in which forestry is so backward, and in which the 'forest sense' is so lacking, as Britain". And he continued: "It will be asked, therefore, Has Britain been able to give a proper example to the Colonies? The answer is that India did so, and throughout the book it will be noticed that Indian forest officers and Indian methods have been frequently employed in the Colonies. Indian forest officers have often been called in at the beginning of forestry operations, as well as at the later stages, and it has been found that Indian forest methods and legislation can often be adapted to Colonial need".

These statements obtain justification from Professor Stebbing's article and, indeed, it would seem that Indian forest methods and legislation should have been adapted to Colonial needs more often than they have been.

From the early days the spoliation of the forests of the Colonies began and it continued when timber was first exported and entirely

unregulated fellings took place, or, as Professor Stebbing writes: "Sawmills are actually working in Government reserved forests of which the head of the department has no stock map!"

It would be well to look at the beginnings and try to find out why Colonial forestry has not been as successful as it might have been.

The Indian Civil Service, with all its faults, set a very high standard of intelligence, application and devotion to duty, and the other important services followed its lead. To take two, the Public Works Department and the Forest Department, they had behind them the training and prestige of Coopers Hill and, at any rate before the last war, the recruits found it perfectly natural when they arrived in India or Burma to take their places in a very efficient working machine, a service with long and valued traditions.

The results obtained are sufficiently set forth in Professor Stebbing's article and there is no need to repeat them. One important matter he did not mention was the extremely good circular published by the Government of India and printed in the Indian Forest Code, in which it was plainly stated that the forests of India (and Burma) were to be worked for the good of the people. The specialized trade in the luxury timbers of Africa hardly comes within this definite aim.

It appears that the Forest Services of the Colonies never got a good start as did the Indian Forest Service. It is believed that the administrative services were rarely so good as in India, and the higher officials had not often been trained to take any interest in forestry and yet about one-third of the total area of the Colonies was under forest, and, as Professor Stebbing has shown, this valuable property deserved suitable management from the start. Surely it should have been realized by the Governors and their secretaries that the forests were a very great asset, and would be a greater one in the future?

From Simla to Mergui in Lower Burma is about two thousand miles in a straight line, and from Freetown on the West Coast of Africa to Zanzibar on the East Coast is about 3,750 miles. If one Inspector-General of Forests was able to keep in touch with the whole of India and Burma before the days of aeroplanes, why

should one Inspector-General for Africa not now supervise the forestry work of Sierra Leone, the Gold Coast, Nigeria, Uganda, Kenya, Northern Rhodesia, Nyasaland and the mandated territory of Tanganyika, and even perhaps Cyprus and Palestine? The argument that the forests are so different over the whole extent of these countries that one man could not control their management is of little value, because no forests could be more different than those of the Himalayas and Tenasserim, and the control of one Inspector-General of Forests had always been found satisfactory in India. In fact, the Government of India, although the provinces are largely independent in forest matters nowadays, has no intention of doing away with the Inspector-General of Forests.

For Ceylon, Malaya, Mauritius, North Borneo and Sarawak, and perhaps Fiji, it should be possible also to have an Inspector-General, and surely the Colonies in the West Indies could supply and afford to maintain a similar officer.

The suggested arrangements would work out somewhat as follows:

			Square miles of Forest.
Africa and Cyprus	... 9		
Eastern, Indian Ocean and		Colonial Dependencies	... 433,000
Pacific	... 6	,, ,,	... 127,000
West Indies and Atlantic	... 4	,, ,,	... 86,000
Total	... 19	Total	... 646,000

Out of this area only about 60,000 square miles have been formed into forest reserves, but it must be noted that very large areas of savannah forests, thorn-bush and cut areas are not included in the forest areas for the Gold Coast, Kenya, Sierra Leone and Tanganyika. It is estimated that in Tanganyika alone there are 70,000 square miles of such forests. For India and Burma the round figures in 1936 were:

Total forest area	430,000 square miles
Reserved and Protected Forests	150,000 ,,

Whereas about one-third of the forest area in India and Burma has been reserved, the proportion in the Colonial dependencies as a whole is probably not more than one-twelfth.

Professor Troup says: "A comparison of the average area of reserved forest per officer in different countries would be of little value, as the progress of reservation varies greatly; in some countries it is nearing completion, in others it has hardly begun".

India has a much smaller area under each member of the superior staff than any of the Colonies where forestry is of importance.

It gives an Indian forest officer a feeling of stupefaction to read that in Northern Rhodesia the average area of forest per officer of the superior staff is 59,000 square miles.

However, according to Professor Troup, "Much of the original forest has been altered in character by shifting cultivation, and the greater part has a low productivity value, though it has potentialities if taken in hand. . . ." Professor Troup says: "It is manifestly unfair to criticize Colonial Administration whose finances will not permit of forest expenditure to the extent desirable, but there can be no harm in emphasizing the fact that future progress in Colonial forestry must depend largely on steady increases of staff as work develops, until a state of equilibrium is reached. One condition essential to progress is the building up of a well-trained native staff; in this respect, India has an overwhelming advantage over most Colonial Dependencies".

It seems that the officials of the Colonial Office have never realized the value of the forests in the Colonies. One looks in vain for any mention of the forests in the speeches of the Colonial Secretary in the House of Commons, and attention is invited to the article on "Recruitment and Forest Policy" from *Nature* of 16th August, 1941, reprinted in Volume 20, No. 2, 1941, of this JOURNAL.

The latest idea of the Colonial Office is to give Forestry probationers one year of training in forestry before sending them out to their Colony, where they are to do several years of apprenticeship before returning to England to finish their training.

This system, adopted against the advice of a number of experienced forest officers, cannot produce good probationers, who should have at least two, preferably three, years' training in forestry before going overseas. It is idle to believe that they will receive adequate instruction in their Colony while carrying out a junior officers' duties.

After the long period during which the Colonial Office has been endeavouring to administer the forests of the Colonies, it seems incredible that it has not on its staff of forest officers a suitable man to act as Forest Advisor, and it is pertinent to ask whether the best men have been given the higher appointments without fear of favour. There appear to be grave faults in both the training and posting of the forest staff.

The necessity for dealing with forestry in the Colonies on sound lines has been emphasized of late by the prominence given to proposals for the administration of the Colonies after the war. An interesting debate took place in the House of Lords on 6th May. Viscount Trenchard proposed that the Colonies should be grouped into areas Governors-General as, for example, the East Indies, West Indies, Africa, East and West. Lord Hailey, who has had almost unparalleled experience of both India and Africa, said that the need for men in the Colonial Services capable of dealing with economic problems had received inadequate attention in the past, and added that our older Colonial literature was full of bitter complaints about the lack of touch between Downing Street and the local administrations. Lord Hailey also said that amalgamation had not only an administrative but a political value. He did not see how they could possibly expect units small in resources to attain to responsible government or the position of a Dominion.

Viscount Cranborne agreed that there was a possibility that the administration of the Empire might gradually develop into larger groups, with the largest measure of political diversity inside the groups.

The latest evidence that the Government is interested in the future of the Colonial Empire is contained in the following extract from the report of proceedings in the House of Commons on 10th June: "*Colonial Research*: Mr. Creech Jones (Shipley, Lab.) asked the Under-Secretary of State for the Colonies whether the names of the Colonial Research Advisory Committee could now be made known; and what large pieces of research were in progress or being visualized. Mr. H. Macmillan (Stockton-on-Tees, U.) replied that the members of the Committee would be: Lord Hailey, chairman; Sir Edward Appleton, secretary to the Department of Scientific

and Industrial Research; Professor A. V. Hill, M.P., secretary of the Royal Society; Sir Edward Mallanby, secretary of the Medical Research Council; and Dr. W. W. C. Topley, secretary of the Agricultural Research Council. The war had restricted the amount of major research being carried out, but it would be one of the first tasks of the new committee to survey the field and make recommendations for the future".

So far so good, but let us look at the percentage of forest in total land area of some important Colonies:

British Guiana	... 87 per cent.	Nigeria	... 60 per cent.
British Honduras	... 90 „	North Borneo	... 82 „
Ceylon	... 67 „	Northern Rhodesia	61 „
Fiji	... 52 „	Sarawak	... 89 „
Malaya	... 81 „	Trinidad and	
Mauritius	... 25 „	Tobago	... 44 „

It is no good saying, "Oh! a lot of that is only jungle". A great deal of it is woodland which will increase in value year by year as more accessible woodlands are exhausted, and will therefore become a growing asset, both for commercial timbers and for other forest products, and also as a means of livelihood for the inhabitants. Surely, therefore, a forest expert should be a member of the Colonial Research Advisory Committee?

The Times, in a leader on 14th March, 1942, says: "The lessons of Malay are many and are not all to be learned or understood in a period of weeks or months. But some of them are so conspicuous and so pressing that there is no excuse for ignoring them; and among these are its lessons in the sphere of Colonial Government. ...

"The defect of the British colonial system, and the essence of the challenge which it has to meet, is that it has been too long and too deeply rooted in the traditions of a bygone age". Is this why we read in "Letters from Singapore", recently published in *Blackwood's Magazine*: "I am surprised how the Malay Civil Service is failing us all. The Civil Power seems totally unable to cope. ..." "What few seem to realize is that the natives, Tamils, Malays and

Chinese too, are looking to the whites for leadership and it is little they are getting".

The Times published in March last two articles by Miss Margery Perham. She begins: "The Malayan disaster has shocked us into sudden attention, to the structure of our Colonial Empire", and goes on to affirm that we must ask whether British rule develops that solidarity which society needs for health in peace as well as for strength in war. The following quotations from her articles are of great interest:

"We might enrich our own experience and revise our ideas of time, scale and scope in education by careful study of the measures taken in Russia, China and Turkey. The colonial peoples are quick to grasp the connexion of poverty and subjection with ignorance, and there is no service for which they ask with the same passion as they do for education.

"In this sphere, as in others, some of our achievements and some of the plans we are slowly maturing are thorough and have been conceived in the truest human terms. But our Adviser on Education at the Colonial Office needs to be Chief of a General Staff of able men and women who would go on tour in order to collect the dispersed experience of our own and other Empires, and offer the resultant stimulus and information to our governments and teachers. And since no foreign rulers can supply from above the dynamism we observe in this field elsewhere, much greater efforts should be made to evoke and to harness that which is waiting below".

"To-day, behind the impressive set-up of chiefs, courts and councils, the welfare of the people often swings helplessly in the tide of world markets, or is controlled by strong and remote commercial companies responsible only to themselves".

"Our Colonial Empire is too varied and gives too much play to initiative, native and British; to be a suitable subject for complete generalizations, and there is no statement in this article that could not be challenged from some part of the Empire. In much of Africa our services have been vital and progressive. In the West Indies, after long blindness, we have lately made a new start. All

over the Empire there are exceptional officers who chafe at the obstacles in their way or break through them. A reforming spirit, to which Lord Hailey has done much to give substance, has lately appeared in this country and needs reinforcement from the new intolerance of official delay and privileged incompetence which the present crisis has aroused in Britain".

"For all Crown Colonies, moreover, the final responsibility still remains in this country. The degrée of interest and knowledge here will decide the quality of the men who devote themselves to the Colonies, whether as Secretaries of State or as junior cadets in the Service. No bureaucracy can work effectively unless it is braced by interest, study and criticism. Until this comes more effectively from the governed, it must be supplied from Britain through a Parliament better constituted than hitherto to carry out this responsibility, or else remote colonial administration must flag into a stale routine. "Nothing can make up for the misery and loss suffered in the territories Japan has conquered. It would, however be some compensation if they stirred us to read those passages in the writing on the wall which refer to our Colonial Empire, and which warn us to infuse a new energy into its administration and to achieve a new and more intimate and generous relationship with its peoples".

It may be thought that there is no justification for introducing these great matters into a discussion on forestry in a technical journal, but the writer has always been convinced that good forestry is of the utmost benefit to a country and a people and it is for this reason he has made these quotations. He believes that the forest officer is often able to understand the temperament of the inhabitants of remote parts of a country better than any other official, and in the Colonies (as in India and Burma) there are many remote parts where the forest officer is almost the only embodiment of Government. For these reasons it seems to be of the utmost importance that the forests and the forest service in the Colonies should be given a prominent place in the reorganization which appears to be inevitable in Colonial Administration, and surely the best way of doing this is to let the forest services see that they are considered as one of the greatest assets of the Colonies, that their officers are to be treated with the utmost consideration by the Colonial Office and by

Local Governments, so that the forest estates may be developed and improved on sound lines for the good of the Colonies which own them.

[The writer desires to acknowledge with gratitude the help he has received from the late Professor Troup's last work, *'Colonial Forest Administration'*.

—*"Empire Forestry Journal," Vol.* 21, *No.* 1, 1942.

WHY CHEMICAL CONVERSION OR UTILISATION OF WOOD IS A PART OF FORESTRY?

By D. S. Jeffers

University of Idaho

Curricula in forestry schools are set up as academic disciplines required for the training of prospective foresters. It is too much to expect unanimous agreement upon the disciplines to be included in any one curriculum. Much of the same confusion of means to the end of the goals of forestry surrounds any effort at a definition of forestry. In many respects the inclusion of chemical conversion and utilization of wood as a part of forestry depends upon the interpretation of the word "forestry".

Forestry involves the management and administration of wildlands, in contrast with cultivated land. Regardless of ownership of these lands, trained foresters are sought for administrators. It is the first responsibility of the forestry schools to train students who may look forward to such employment. But Forestry goes beyond land administration, and likewise the responsibility of the forestry schools is not answered if only land administrators are trained. The lands of the forests are put under management in order to perpetuate the resources thereon and therein and to make available for economic use by the greatest number of people the products and services that are inherent in the permanent and renewable resources of the land. For the immediate future this concept includes not only the production and harvesting of the crop envisaged in the administration and management of a forest, but it is necessary for the forester to make provisions for processing, marketing, research, and development of all the varied resources of the land. The success of

forestry is thus dependent in part upon the ability or failure of such enterprise to produce returns.

When we stop to count the number of years that the profession of forestry has been recognized as such and compare that short time with the age of other and older technological professions, it is safe to assert that a decade in the forestry profession is quite close to one fourth its life span. It was ten years ago that Graves and Guise set the standards of forestry education and gave expression to the following oft-quoted paragraphs:

"In managing timber resources, the task of forestry does not stop with the growing of trees and their replacement after cutting. It includes also the economical and efficient use of wood products. The manufacture, distribution, and use of wood products are intimately related to the growing of the raw materials. This statement does not mean that logging, lumber, manufacture, and merchandising of forest products, taken by themselves, constitute forestry. These activities become an important feature of the forestry enterprise only when they are correlated with and contribute to the conservation of the forests on which their permanence depends. Conversely, silviculture can be carried on successfully only when correlated with industrial and economic requirements.

"The preparation of foresters in forest utilization, as a feature of their professional capital, involves three broad aspects: first, a knowledge of wood, its properties and uses; second, an understanding of the engineering and industrial processes involved in preparing the materials of the forest for use; and third, a grasp of the economic problems connected with utilizing forest products. The economic aspects pervades all work in forest utilization and should be kept constantly in the foreground in work with students. Forest utilization is broad in scope and diversified in character, affording opportunity for specialization both in research and in industrial activities."

With the above in mind, one naturally inquires as to the usefulness of forest products and in so doing carefully examines all phases of the national economy wherein wood and wood products play or may play a role. The examination, of course, immediately brings out the usefulness of wood in providing shelter, comfort, and

heat; the latter a form of chemical conversion used throughout the ages. With the advance in civilization, however, new, and in some cases more satisfactory, materials were discovered to serve such purposes and a decreased demand might be expected for forest products. The enterprize thus naturally seeks other outlets for its materials to balance the offset demand, and we might consider that which was probably the first form of chemical conversion; the charcoal industry. This enterprize, originally developed in Germany for the production of fuel in reducing iron ore, enjoyed a period of great prosperity. Of course, the introduction of coke as fuel for such purposes was a serious blow and the industry, in an effort to offset the disadvantage, examined its erstwhile waste materials as by-products. The success attending the effort is well known and the function of this industry, even in the last war, through the production of methyl alcohol, acetone, and other valuable chemicals was of greatest importance. In recent years we are all familiar with the variety of building boards of wall and construction type developed in many cases synthetically to supply the industry with a product of uniform dimension and grade and permitting a reduction in labor and construction costs. The advent of such materials materially decreased the use of lumber, and this was immediately reflected in forestry. The efforts of the industry to meet such competition resulted in the development of its own synthetic boards, again by a process of chemical conversion and employing up to 90 per cent. of its own resources, this often in the form of otherwise waste products. Furthermore, in the same field the plywood board, comprising a thin veneer backed by plies of less desirable species and often of low grade, has enjoyed outstanding success. With the introduction of the newer glues and bonding agents of the phenol formaldehyde, urea-formaldehyde types the plywood industry may expect still greater application, particularly in moist locations and under conditions where decay is a major factor.

The two examples, one from the old and a second from recent times, indicate that the success of any commercial enterprize is dependent upon its ability to meet competition not only in its own field but also from other sources wherefrom other new products may render the enterprize obsolete almost overnight. The develop-

ment of suitable protection of course involves salesmanship, promotion, and advertising to extend existing markets and in an intensive well-organized program of research and development for the production of new materials, new products, and new methods of utilizing existing products. In truth, we live in a changing world and *in many cases the new embryonic industry becomes of greatest* importance.

We may thus consider the chemical conversion of wood as one of several methods for developing new and extended uses for forest products, reflecting its advances in the increased practice of forestry as chief supplier of raw materials. Chemical conversion might be chosen in preference because of the great versatility of the art. In many cases the new product bears scant resemblance to its original forest form. As specific example we think of the pulp and paper industry producing a cellulose pulp with its own multifold uses and now its adaptation as the acetate or ether to the production of plastic and artificial silk. The expression from "logs to lingerie" has foundation in fact.

These items, and others unmentioned but of equal importance, all point clearly to the conclusion that forestry might well take fullest advantage of the fundamental process of photosynthesis. As a matter of fact, this reaction is the only known example of a low energy system being raised to one of higher energy level, and this takes place only in the plant kingdom. Forestry is therefore concerned with a process of creation centred upon the elemental carbon atom and is really intimately related with many phases of chemistry. Carbon, as is well known, is practically the only element possessing the power of self-combination, and together with the elements of water gives rise to the carbohydrates, essentially the first products of plant metabolism. Proceeding from this preliminary synthesis, effected in the presence of chlorophyll by energy derived from sunlight, the plant, according to theory, produces cellulose, lignin, and other components. The former, representing the largest percentage of wood is actually a high molecular weight polymer of glucose synthesized in vivo by methods which cannot be duplicated in vitro. Merely in the tailoring of such molecules man has been particularly successful in producing many new products so common

in everyday life. Such advance and consequent increase in the consumption of cellulose only became possible after years of study of a type related to chemical conversion.

Significantly enough, the photosynthetic reaction is but one portion of a complete cycle beautifully illustrating the fundamental laws of conversion of mass and energy. Thus, the elementary substances combining in the reaction proceed to the more complex compounds with gradual increase in carbon content and corresponding loss in the elements of water. We thus proceed through cellulose and lignin to humus, peat, coal, and petroleum, and finally by combustion, to the original elementary substances. No loss of matter, is entailed in the process and the energy entering the system during photosynthesis is returned calorie for calorie in the combustion stages of the cycle.

It is apparent that forestry is actually but one part of a complete cycle based upon the fundamental laws of nature. Forestry management and administration are concerned with the life phases of that cycle, while in chemical conversion of wood the goal is to render the forestry phase of greater significance by the diversion of those naturally synthesized chemical compounds into channels of commercial enterprize of benefit to the race. A reasonable conclusion is that the complete field of forestry is covered in our curricula only when full consideration is given to chemical conversion and utilization of wood.—*"Journal of Forestry", Vol. 40, No. 2, dated February, 1942.*

INDIAN FORESTER

JUNE, 1943

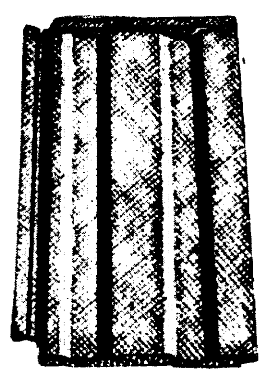
CEMENT ROOF TILES

BY M. D. CHATURVEDI, B.SC. (OXON.), I.F.S.

Summary.—Cement tiles as a roofing material for forest buildings compel consideration for their strength, neat appearance lightness and above all economy. Made as they are, on the spot the saving effected in transport costs is not inconsiderable. The mixture recommended is sand 3 to cement 1. No reinforcement is required. Machines of various types are available in the market. For curing tiles, complete immersion under water yields best results. Attractive colour schemes could be introduced as desired. The cost at the present high rates amounts to about Rs. 10 per 100 sq. ft. of roof covered.

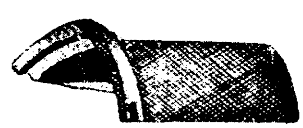
Of the various types of roofing materials used in forest buildings, cement tiles compel consideration for their strength, neat appearance, lightness and, above all, economy. The machine employed for the manufacture of tiles is inexpensive, portable and easy to handle. In the hands of a trained mason and two assistants it yields about 100 tiles a day. Moulds of various designs are available. Special moulds are used for ridge tiles.

Fig. 1



Roof Tile

Fig. 2



Ridge Tile

The materials used are cement and sand and no reinforcement is required. The proportion recommended is 1 : 3. Attention must be paid to the following details regarding the materials employed.

(a) *Sand.*—Must be coarse, clean, sharp, dry and free from clay and organic matter. The grain should not exceed $\frac{1}{8}$ inch and not more than 1 per cent. by weight should pass a sieve with 10,000 meshes to the square inch. For the same strength, finer grain of sand requires more cement to go round each particle, and the mixture must be made richer involving waste of cement. Exceedingly fine sands should, therefore, be rejected. It is advisable to wash the sand used for this purpose in clean flowing water and dry it thoroughly. Wet sand increases in volume, upsetting its proportion to cement. The organic matter and clay should not exceed 2 to 3 per cent. A higher proportion will affect the hardening of the cement adversely.

(b) *Cement.*—Any of the well-known brands of cement can be used. Rapid hardening cement is recommended.

(c) *Water.*—Use clean water. Only sufficient water should be added to the mixture so that it may retain shape under its own weight.

The pallets (moulds) are best kept clean with a wire brush. Heat if necessary. The pallets should be oiled (crude oil) before and after use to prevent the mixture from sticking. The body mixture should be thoroughly rammed in order to form a strong dense tile. The moulds should be a little over full when the striker is used and pressure should be employed to ensure a smooth and dense surface after the excess has been scraped off. The denser a tile, the less the afflorescence. Sprinkling of cement on top of the tile gives an exceedingly fine finish.

Cement sets best in a moist and warm atmosphere. The tiles must be kept in their pallets in shade for at least 24 hours, if rapid hardening cement is used. By far the most convenient way is to stack them on wooden racks. Two 1 inch by 1 inch battens, $4\frac{1}{2}$ ft. long nailed 12 inches apart to two $1\frac{1}{2}$ inch by $1\frac{1}{2}$ inch cross pieces 18 inches long form a cheap and satisfactory rack. A rack of this size will hold five pallets. Plain wire or strong rope loops on either end of the rack render their handling easy. Complete immersion of tiles under water, rack by rack, gives very satisfactory results. After

three days the racks are taken out from water and tiles stored under wet grass covered with gunny bags, kept wet. The tiles must be stacked under shade, and bright sun should be avoided.

While the grey tiles resulting from the natural colour of sand and cement have an attractive appearance, bright colours can also be introduced, if desired. For roofing tiles the most popular colours are red, yellow, black, brown and green and mottled red black. These colours are best derived from:

Red	...	Iron Oxide.
Yellow	...	Iron Oxide or Hydroxide or mixture of the two.
Brown	...	Iron Oxide or Hydroxide or Manganese Oxide.
Green	...	Chromium Oxide.
Black	...	Iron Oxide or Manganese dioxide.

Pigments affect the strength of the tile adversely, and must, therefore, be used sparingly. The colours must be of good quality and fine in texture. They should not fade, and must not effloresce.

By far the most economical method of colouring tiles is to introduce the required pigment in water used for the mixture. This secures uniform colour in the body of the tiles. The face of each tile is finished by sprinkling on it a dry finely ground and intimate mixture of sand, cement and colour known as 'topping'. A tray with wire mesh at the bottom is a standard fitting to the tile making machines for sifting 'topping' on.

To ensure uniformity and fixation of colour used, tiles are dipped in constantly stirred solutions immediately after depalleting for a few minutes. The tile being still raw, the solution soaks into its very core. The moisture so introduced promotes hardening.

The solutions commonly used are:

I. *Ferrous Sulphate*

Chemically reacts on cement, changing its colour to shades ranging from light buff to deep reddish-brown. It deepens and fixes colour in freshly depalletted tiles.

The stock solution is best made by dissolving 7 lbs. of ferrous sulphate in two gallons of hot water. A dilution of one gallon of concentrated stock solution with 14 gallons of water will ensure best results with red, brown, yellow and black tiles. The required colour should be added according to the intensity desired. Approximately 7 lbs. of red oxide to 14 gallons of diluted solution will give a good red tile.

II. *Ferric Chloride*

Solutions are of recent origin securing a pleasant orange tint. The stock solution is made by dissolving 3 lbs. of ferric chloride in one gallon of water. One gallon of the concentrated solution is diluted with 28 gallons of water. The chemical reaction of ferric chloride on cement has been shown to have a much better effect than of ferrous sulphate.

III. *Copper Sulphate*

With green pigment is used in the same concentration as ferrous sulphate to give green tiles.

The following facts and figures about tiles will be found useful in building estimates:

(*a*) Size—$15\frac{3}{8}$ in. by $9\frac{1}{2}$ in. by 1 in.

(*b*) Weight—$6\frac{1}{2}$ lb. approximate.

(*c*) Mixture—Cement 1 : sand 3 by volume.

(*d*) Area—1,000 tiles cover 700 sq. feet.

(*e*) Breaking load—125 lbs. when wet, 175 lbs. when dry.

(*f*) Ridge roof tiles are $15\frac{3}{4}$ in. by 9 in. by $\frac{3}{4}$ in., each weighing $7\frac{1}{4}$ lbs.

Tiles must overlap one another sufficiently to prevent leaks which is a common cause of complaint. Cement pointing of tiles on the upper surface after laying them, makes the roof leak-proof.

The materials required for the manufacture of 1,000 tiles are given below:

Cement (rapid hardening)		...	1,420 lbs. or 17.75 c.ft. approximately.*
Sand	... ...	...	5,175 lbs. or 53.25 c.ft. approximately.*
	Total	...	6,595 lbs. or 71.00 c.ft.

Water used is about 14 per cent. of the volume of the materials used. The cost of tiles works out at Rs. 70 per thousand, taking into consideration the current rise in prices. Thus Rs. 70 is the cost of covering 700 sq. ft. of roofing which is Rs. 10 per 100 sq. ft. Attention need only be drawn to the prohibitive transport costs of other forms of roof materials for usually inaccessible forest buildings against cement tiles made on the spot.

LITERATURE

1. Baumgarten, R. H. & Childe H. L.—Manufacture of Concrete Roofing Tiles, Concrete Publications, London.
2. Killick Nixon & Co., Bombay.—Concrete Products Machinery.
3. Concrete Products. Experiments on production costs.—The Concrete Association of India, Bombay.

* Weight of 1 c. ft. of cement is—

Ordinary	= 90 lbs.
Rapid Hardening ..	= 80 lbs.
Weight of 1 c. ft. of sand	= 97.5 lbs. (varies between 95 to 100 lbs.).

ON THE FOOD AND FEEDING HABITS OF THE INDIAN GLOW-WORM (*LAMPROPHORUS TENEBROSUS*, WALKER)

BY J. SAMUEL RAJ, B.A., B.SC. (HONS.)

(*Department of Zoology, Madras Christian College.*)

That glow-worms feed on snails and slugs is known from very early times. Newport and Ellis (1857) give a series of experimental observations on the feeding habits of the larvæ of the European *Lampyris noctiluca*. Prof. Ellis supplied the same larvæ with *Helix nemoralis* and *Limax agrestis*. Kathleen Haddon (1915) has described the method of feeding and larval mouth parts of *L. noctiluca*. Paiva (1919) gives a brief account of the feeding habits of the Indian glow-worm, *Lamprophorus tenebrosus*. Hutson and Austin (1924) in their bulletin on the Indian glow-worm describe it as "an enemy of the African or Kalutara snail, *Achatina fulica*." Even the aquatic larvæ of *Luciola vespertina* are found to attack and devour water snails (Blair, K. G. 1927). *Luciola gorhami* in the larval state feeds voraciously on worms and molluscs (Mehta, D. R. 1932). The glow-worm, *Lamprophorus nipalensis* is described by Parsons (1942) to have fed on a slug. Although the larvæ are known to be very carnivorous, it is interesting to note that the adult *Lampyrids* take little or no food. (Fowler, W.W. 1912; Hutson and Austin 1924; Imms, A.D. 1938; and others.)

The Giant Indian glow-worm, *Lamprophorus tenebrosus* Wlk. is a fairly large and stout form growing up to 3 to 4 inches in length. It is obtainable from inside bushes in Tambaram, Chingleput District almost throughout the year, although the early larval instars and adults make their appearance only during the rainy months. The life-cycle is spread out throughout the year. The adult males and females are not so abundant as the larvæ. The males which are winged and very much smaller do not feed at all. A dissection of the alimentary canal of the males reveals it to be mostly empty. If kept in a trough they move about for some time, remain inactive for a few days and die soon. The females, of which only four were collected in October, 1941, are apterous, creamy white in colour and larviform. They were supplied with snails, slugs and worms, but did not feed.

The larvæ on the other hand feed voraciously on snails. My observations on the larval feeding habits were carried out in Madras Christian College, Zoology Laboratory, during the years 1939—1942. Till now several hundreds of snails were consumed by over a hundred larvæ. The glow-worms were all collected from the college premises at night. They creep about the footpaths and grasses at night, and on several occasions I have collected them at the very act of feeding. The snails usually attacked by the later larval instars belong to the genus *Ariophanta*. The two species which are usually attacked by the glow-worm are *A. ligulata* and *A. bistrialis*, the former being preferred to the latter. In Ceylon the same form feeds on a larger snail, *Achatina fulica* (Hutson & Austin, 1924). Paiva's glow-worms were supplied with *Macrochlamys indica* and a few *Achatina fulica* (1919) and his observations were made from only two larvæ, one from Rambha and the other from Angul. Hutson and Austin have studied the total number of snails eaten during the larval period. According to them the female larvæ consume more snails than the male larvæ.

The glow-worms are very active at night. They creep about and walk long distances in search of snails. They even climb large *Casuarina* trees after the snails. On certain occasions some full-grown larvæ were observed falling down from very high branches of *Casuarina* trees with lightning flashes. *Ariophanta* are found in large numbers creeping freely over the branches of the bushes and on land. The glow-worms also are found to live among these trees. During summer when all the snails climb up the trees and aestivate, the glow-worms also climb up to insert their heads into their shell and attack them. During my nocturnal hunts after the glow-worm several empty fresh shells of *Ariophanta* with their dark excreta exuding were noticed. These, I believe, must be the shells of snails attacked by glow-worms. The glow-worms are known to control to some extent the spread of snails. The large African snails, *Achatina fulica* of Ceylon "is now a recognized pest, causing considerable loss owing to its depredations in vegetable gardens in the low-country region."* Snails-suppression by introducing glow-worms was tried

* Madras Fisheries Department Bulletin, Vol. XIV, Madras Fishery Investigations, 1921, Second Series.

in different places and "there are indications however that this large glow-worm (*Lamprophorus tenebrosus* Wlk.) is doing an appreciable share in keeping down the snail around Peradeniya at any rate."* *Lampyris noctiluca* was tried for the control of *Helix aspersa*.†

It is yet to be seen how far the present form *Ariophanta* is detrimental to vegetation and how far the giant glow-worm can control it. Still, at present, it can be said with little hesitation that the rapid spread of the snails in Tambaram is to some extent controlled by the glow-worm.

Most of my observations were carried out with full-grown larvæ and full-grown snails. Inside the laboratory the larvæ feed both during day and night. They feed usually until their integument swells up and sometimes because of overfeeding the animal finds it difficult to coil itself. They are voracious feeders throughout their larval period. Very active and voracious feeding stage is centred round the middle of every larval instar. Feeding ceases for about a week before and a few days after ecdysis. During feeding the *anal brush* (Raj. J.S. 1941) always comes into play. The anal brush is a very essential and very conspicuous structure belonging to the last abdominal segment. It is in the form of a white tuft of clusters of filaments all kept moist by the white slimy fluid from the body cavity. The whole brush can be completely retracted into the segment or spread out over its body. It is a wonderful structure peculiar to the *Lampyrid* larvæ, but unknown among the adult males. Each brush filament is provided with several rows of strong recurved chitinous teeth. The brush is bathed in a slimy secretion which makes it sticky. The whole brush is firmly held together by a special chitinous sclerite located posterior to the ninth abdominal segment. This special plate is an arched piece which embraces the base of the brush from the sternal aspect. Dorsally the two ends of the piece are seen to dilate but never meet. The anal brush serves two essential purposes, one to give a strong hold to the bearer during the burrowing operations or locomotion or when attacking a snail, and secondly to clear the body especially during the struggles with the prey. Usually when a snail is attacked it exudes a slimy froth which spreads over

* Ceylon Agricultural Bulletin No. 69.
† Review of Applied Entomology, XVII, 1939.

the body of the glow-worm, which frees itself from the froth with the aid of this brush. On several occasions it was noticed that the anal brush holds very strongly to the ground when inserting the head into the shell. The cleaning operation by this strange organ is indeed interesting. The larva curves round and always starts cleaning from the head backwards. By constant retraction and protrusion of the brush the dirt particles are taken and, finally, when the brush is heavily laden with dirt particles the whole mass of dirt is deposited on the ground.

Feeding is a very slow process and usually a single full-grown larva takes about 6 hours to consume a single fairly large-sized *Ariophanta*. In certain cases the feeding time is longer and it takes even 12 hours. At this rate a single glow-worm can consume only from 1 to 3 snails per day. According to Paiva "the number of small snails (*Macrochlamys indica*) usually devoured in one night was about four". The following chart shows the duration of feeding observed from a single full-grown larva:

Date.	Feeding begins.	Feeding ends.	Duration.	Average time.
9th Oct. '42	9-30 a. m.	4-00 a. m.	6 hrs. 30 min.	
12th Oct. '42 ..	2-45 p. m.	9-30 p. m.	6 hrs. 45 min.	6 hrs. 20 min.
13th Oct. '42 ..	6-30 a. m.	12-40 a. m.	6 hrs. 10 min	(approximately.)
14th Oct. '42 ..	8-00 a. m.	1-50 a. m.	5 hrs. 50 min.	

A break is sometimes observed during feeding when the glow-worm leaves the snail, creeps about and cleans the body for a fresh attack. When a snail is attacked it is consumed completely. It sucks off everything except the shell and the contents of the alimentary canal. A snail attacked usually never escapes. The whole process of feeding takes place in three distinct stages: (1) Attack, (2) Fight, and (3) Sucking or actual feeding.

Before the attack the animal stretches out its head and antennæ and moves the labio-maxillary plate over the body of the snail. The stout maxillary palpi work up and down to feel the snail. The attack is sudden and made in most cases at the foot of the snail. The attack

is in the form of a stabbing and is done by the claws of one of the legs or by the mandibles themselves. This gives intense pain to the snail and the snail wriggles into the shell. There is also a simultaneous exudation of a kind of slimy froth from the snail. The larva is caught inside this froth, but the head escapes from it as it is entirely retracted into the thorax. The retractability of the head is thus a~~n~~ ~~extent in feeding. Actual feeding operations involve regular but~~ special adaptation for its peculiar mode of life. Besides being an adaptation during the burrowing operations, it also helps to a great extent in feeding. Actual feeding operations involve regular but rapid retraction and protrusion of the head. A series of these operations take place side by side with special movements of the mandibles. The retraction of the head is brought about by the contraction of a set of muscles and helped to a large extent by the extensive development of the cervical integument from the base of the head-capsule to the prothorax. The interior of this extensive sheath is in communication with the body cavity. When the head is fully stretched out, the milky white odorous fluid of the body cavity flows into the cervix and keeps it turgid. The antennæ also are highly retractile. This makes the head fit for tunnelling into the slimy froth of the snail. The outer surface of the cephalic capsule is smooth and this gives easy access into the slimy food material. m Again the possession of a mediu~~m~~ suture in the dorsal plates allows easy penetration of the larva into the shell.

In most cases when the snail withdraws into the shell, the glow-worm also is dragged along with it. Sometimes when there is too much exudation of froth, the larva wriggles its way out of the frothy tangle and cleans itself and again renews the fight. At other times a regular fight ensues between the struggling snail and the pugnacious larva. Very interesting things happen during the fight. In a few cases all of a sudden the snail comes out, creeps forcibly out of the shell and walks over the back of the grub! In most cases the very first prick received from the glow-worm gives something more than a mere mechanical injury to the snail. It makes the snail wriggle out of intense agony. But there are occasional cases where the snails live even after the first prick or stab without being affected in any way. During the fight with the snail

a dirty brownish secretion is seen to overflow from the mouth and poison the snail. Although this flow of fluid from the mouth is noticed previously by earlier observers, its exact function and place of secretion is still unsatisfactorily known. In the present larva this dark fluid oozes out of the mouth and spreads over the wound. On dissection of several larvæ a similar fluid was seen inside the stomach. So most probably the contents or some special secretion of the foregut is regurgitated out through the mouth and injected into the prey and this may serve either to benumb the prey or may aid in digestion or may serve both. Till now no special poison glands or salivary glands have been noticed in the neighbourhood of the mouth.

After the fight and as soon as the snail is benumbed the slow process of sucking begins. During sucking the tips of the mandibles are found to be buried in the tissues of the snail and the head alternately moves forwards and backwards and the tissue is crushed into a semifluid condition by the basal tooth of the mandible and the tuft of hairs borne in the neighbourhood of the mouth. The mandibles are pierced by a long tube which opens into the buccal cavity. The buccal cavity bears basally the hypopharynx and laterally the mandibular appendages. The roof is formed by the strong labro-epipharyngeal apparatus. A very important and characteristic feature of the mouth parts of the larva of *L. tenebrosus* is the presence of a profuse growth of hairs. The mandibular bases are thickly clothed with hairs. So also are the mandibular appendages, which are in fact formed of a thick sheet of short hairs. The hypopharynx is armed with hairs. The labio-maxillary plate bears medially a strong tuft of hairs. These help the larva to crush the food and also act as a filter. The mechanism of sucking is not fully understood, but there are evidences to show that food is sucked in not only through the mandibular canals but also through the median mouth opening. In both cases the food is filtered completely from solid particles. The very long and narrow œsophagus springs from the pharynx. A knowledge of the details of cephalic musculature and armature is necessary for a thorough elaboration of the exact process of feeding.

Besides living snails, the large whitish eggs of *Ariophanta* are also eaten by the glow-worms. The glow-worm lifts up the egg by

the mandibles and places it over the head and brings it lower down between the mandibles which suck off the contents of the egg until the egg-shell alone is left. Sometimes the earthworms also are attacked. On one occasion a full-grown larva was obtained at the very act of feeding on a large earthworm. The earthworm was almost cut into two and two halves were wriggling coiled round the glow-worm. After removal to the laboratory, the earth-worm was seen firmly held in position by the legs and the glow-worm was slowly feeding on it. The mandibles were working vigorously and in the course of about four hours the whole earthworm was consumed leaving behind only the contents of the alimentary canal. In certain cases they are just cut into two and then left undisturbed. Although carnivorous, the glow-worms are very rarely cannibalistic. On the other hand they present extreme gregariousness. When left in a trough they are always found to cluster into a heap one above the other. During burrow-making they are frequently seen elbowing their way into the same burrow and even during feeding sometimes two or even three thrust their heads into a single shell.

BIBLIOGRAPHY

(1) 1826 M.M......., de Rouen.—"Note sur les habitudes naturelles des larves de Lampyres" Annales des Sciences Naturelles, Tome VII, Pp. 353—356.

(2) 1839 Westwood, J. O.—"Introduction to the modern classification of Insects," Vol. I.

(3) 1857 Newport, G.—"On the Natural History of the Glow-worm (L. noctiluca)" Journ. Proc. Linn. Soc. (Zool.) Vol. I. PP. 40—71.

(4) 1883 Bates, H. W.—"Cassell's Natural History."

(5) 1907 Olivier, E.—"Fam. Lampyridae." Genera Insectorum, 53 me Fascicule.

(6) 1915 Haddon, K.—"On the methods of feeding and the mouth parts of the larva of the glow-worm (L. noctiluca)" Proc. Zool. Soc. Lon. PP. 77—82.

(7) 1919 Paiva, C. A.—"Notes on the Indian Glow-worm" Rec. Ind. Mus. Vol. XVI.

(8) 1924 Austin, G. D.—"The Indian Glow-worm (*Lamprophorus tenebrosus* Wlk.)" Year Book Dept. Agric. Ceylon.

(9) 1924 Hutson, J. C. & Austin, G. D.—"Notes on the habits and life-history of the Indian Glow-worm." Dept. Agric., Ceylon, Bulletin No. 69.

(10) 1927 Blair, K. G.—"An Aquatic Lampyrid Larva from S. Celebes" Trans. Ent. Soc. Lon. PP. 43—45.

(11) 1932 Mehta, D. R.—"Preliminary notes on the life-history of the fire-fly *Luciola gorhami* Rits., and cytology of the light organs." Bull Dept. Zool. Punjab Univ.

(12) 1941 Raj, J. S.—"The Giant Glow-worm of Tambaram" Madras Christian College Magazine, Vol. XI, No. 2.

(13) 1942 Parsons, R. E.—"Glow-worm (*Lamprophorus nipalensis* H.) feeding on a slug." Journ. Bom. Nat. Hist. Soc. Vol. XLIII No. 1.

(14) 1942 McCann, C.—"Glow-worms (*Lamprophorus sp.*) feeding on molluscs." Journ. Bom. Nat. Hist. Soc., Vol. XLIII, No. 3.

(15) 1943 Raj, J. S.—"On the mouth-parts of the Indian Glow-worm, (*Lamprophorus tenebrosus* Wlk.)" Current Science, Vol. 12, No. 3.

EXTRACTS

HOW PLANTS RESIST THE ATTACK OF PARASITES

By Sudhir Chowdhury

All plants which have been cultivated for any considerable period of time exist in innumerable forms or varieties. One of the most striking differences between the varieties of any one crop plant lies in their varying susceptibility to specific diseases; one variety may be extremely liable to a certain malady and another may be completely immune.

Considerable attention has been given to the question as to the basis of resistance and susceptibility to disease in plants. Much work has been done and many lines of investigation have been carried out more or less thoroughly, but the problem is yet far from ultimate solution. There are so many different degrees of resistance, real or apparent, that it seems evident that no one factor is responsible in all cases. For convenience in discussion all disease resistance in plants may be considered under two heads: (*a*) *apparent resistance*, and (*b*) *true resistance*. The first of these may be interpreted to include all cases in which for some incidental reason environmental or otherwise, plants which normally would be expected to become diseased escape or avoid disease. The second class includes all cases in which resistance is due to some characteristic, physiological or structural, inherent in the plant life.

Enough work has now been done on this problem to enable us to say that in all probability the basis of resistance is not the same in all cases but that a considerable number of different factors may be concerned. Thus it seems that the probable basis of resistance in wheat to stem rust is not the same as the factor which is the basis of resistance to wilt in certain varieties of cotton. A number of different factors have been named by various workers as the basis of resistance in plants. Some of these factors are discussed below:

(1) *External Structure*:—The morphological characters most often mentioned in connection with disease resistance are those associated with the epidermal structure such as number and size of the stomata, presence and thickness of the cuticle, presence of epidermal hairs and the occurrence of waxes on the surface of the plant.

In several instances the number and structure of stomata have been regarded as factors in disease resistance. The susceptibility of sugar beet towards leafspot (*Cercospora beticola* Sacc.) has been considered to be dependent, among other factors, upon the length of the stomatal pore (1) Doran, (2) demonstrated that the resistance of snapdragons to *Puccinia antirrhini* is conditioned by the number of stomata per unit area. Resistance of stone fruit to *Sclerotinia* cinerea was considered by Curtis (3) to be determined by the toughness of the cuticle and the size of the stomata. Cobb (4) thought that the resistance of certain varieties of wheat to stem rust (*Puccinia graminis*) was due partially at least, to the fact that the stomata of the resistant varieties were smaller than those of the susceptible varieties. Orton (5) found smaller stomata correlated with rust resistance in asparagus. Allen (6) noted that the stomatal opening is smaller in Kanred, a variety of wheat resistant to *Puccinia graminis tritici,* than in Baart, a very susceptible variety. On the other hand Eriksson and Henning and Ward found no evidence that resistance to *Puccinia dispersa* is related to stomatal structure.

Further the growth of the germ tube towards the stomata may be hindered, for example, by the presence of hairs on the leaf surface. The young leaves of the grape vine are not attacked by black rot [*Guignardia bidwellii* (Ellis) V. R.] partly owing to their dense covering of hairs, while apple scab (*Ventuira inæqualis*) seldom attacks the undersurface of the leaves, perhaps because of their hairy nature.

Protective layers of cuticle or of cork have been credited with contributing to disease resistance in some cases. The comparative resistance of the fruit of certain plum varieties to brown rot (*Sclerotinia cinerea*) has been attributed to the toughness of their skin and the firmness of their flesh (7), Willaman (8) by the measurement of these two factors adduced evidence to show that the 'skin test' alone is a sufficient criterion for the determination of the degree of resistance of plum varieties to this fungus. Immature tomato fruits are susceptible to rots due to *Macrosporium tomato* while the older fruits are resistant, due it is said to the fact that the hyphæ are unable to penetrate the thicker cuticle of the more mature fruits. The work of Hawkins and Harvey (9) indicate that the degree of attack

of potato by *Pythium de Baryanum* Hesse is limited by the thickness of the cuticle. Weimer and Harter working with sweet potato rots have demonstrated that the suberization of the cell walls at the surface of the wounds may prevent the entrance of decay organisms. Tisdale (10) found that varieties of flax resistant to wilt (*Fusarium lini* Boll) were able to develop a layer of suberized cells in advance of the penetrating fungal hyphæ, which effectively walled off the parasite. Brooks and Moore (11) mentioned plum varieties resistant to silver leaf (*Stereum purpureum* Pers.) because of their ability to produce excessive quantities of gum which forms a barrier preventing extension of fungal growth.

Those varieties of raspberry which are least damaged by the rot caused by *Coniothyrium* sp. has been found to possess a more waxy surface.

(2) *Internal Structure*:—Resistance in some cases appears to be related to the ease of difficulty with which the parasite can penetrate cell walls by enzymic digestion or otherwise. Since there are apparently chemical differences between the cell walls of different varieties of plants, these differences are reflected in the degree of resistance exhibited by different varieties of host plants to a specific organism. A wall dissolving or macerating enzyme has been reported as the factor which enables *Botrytis cinerea* to penetrate the tissues of susceptible plants (12, 13, 14). Jones (15) found that the soft rot organism *Bacillus carotovorus* secretes an enzyme, pectinase, which enables it to break down the tissues of susceptible vegetables.

Conant (16) has shown that a close correlation exists between the histological structure of tobacco roots and resistance to the root-rot fungus, *Theilavia basicola*. The root tips and elongating regions are relatively immune, apparently due to the inability of the fungus to penetrate the epidermis. Farther back from the tip the epidermis is ruptured due to cambial activity, and since pericyclic activity lags behind cambial activity, no cork has yet appeared, consequently the roots are very susceptible in these regions. The fungus is unable to penetrate cork; therefore as soon as a phellogen appears and begins to lay down cork the fungus is barred from entrance.

(3) *Cell-Sap Acidity*:—The suggestion of Comes (17) that the Acidity of the cell sap determines resistance has provoked much research. Arrhenius (18) could establish to correlation between the

hydrogen-ion concentration of the cell sap and the resistance to yellow rust (*Puccinia glumarum*) in the case of wheat. Hurd (19, 20, 21) showed that the varietal resistance of wheat to the stem rust (*Puccinia graminis*) and bunt (*Tilletia tritici*) is not related at any stage of development of the host to the hydrogen-ion-concentration of the cell sap. The latter worker found that the hydrogen-ion-concentration of the cell sap varies throughout growth and that the resistant varieties of wheat pass through the period of low concentration at the same stage of growth as do the susceptible varieties, yet no breakdown in their resistance at this stage could be detected. Vavilov (22, 23) investigated the resistance of varieties of wheat, oats and roses to rusts and mildew and found nothing to indicate that resistance was due to cell sap acidity. Other workers have failed to find any correlation between cell sap acidity and resistance to disease in case of the potato late blight (*Phytophthora infestans*), leak of potato (*Pythium debaryanum*) and potato wart (*Synchytrium endobioticum*).

On the other hand cases of the correlation of the acidity of the cell sap and the plants' degree of resistance have been reported. Gardner and Kendrick (24) found that seedlings, leaves and green fruits of tomato were very susceptible to *Bacterium exitiosum* G. & K while ripe fruits were resistant. This condition was found to be correlated with a higher acidity in the ripe fruit than in the other parts of the plant or in the green fruit. Molz (25) reported that with the vine those varieties resistance to mildew have leaves whose sap contains 4.3 to 10.3 per cent. acidity whereas the more susceptible varieties have but 0.5 to 2.6 per cent. acidity. It is reported that in the case of the black rot of grapes (*Guignardia bidwellii*) the more susceptible varieties are richer in acids and form sugars late whereas the more resistant varieties have little acid and become rich in sugar early in life.

(4) *Tannin and Glucosides*:—The precise role of tannin and related phenolic compounds in a plant metabolism has been widely debated (26) and it is not impossible that they serve for defence. Cook and Taubenhaus (27) suggested that the greater susceptibility of mature over immature fruit to fruit rots is associated with the smaller content of oxidase in the mature fruits. The oxidase they considered served to protect the infected fruit by the liberation from the tannin of phenolic derivatives toxic to the invading fungus.

Newton and Anderson (28) obtained evidence that phenolic substance, determine the resistance of wheat to rust, whilst Dufrenoy and his colleagues (29) showed by micro-precipitation methods, that phenolic compounds are formed in the host plant cell adjacent to infected cells. Thus he demonstrated that the cells of bean plants resistant to *Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav. developed tannin vacuoles whereas infected cells of susceptible plants became crowded with starch grains.

Alternatively certain glucosides have been considered to be the active means of defence of resistant varieties. Tims (30) suggested that the resistance of cabbage to cabbage yellows (*Fusarium conglutinans* Wollnw.) is due to toxic principle, possibly a sulphur containing glucoside, present in the tissues of resistant varieties. Reynolds (31) recognised two types of substances present in flax extracts and toxic to *Fusarium lini*: firstly the glucoside *linamarine*, which appeared to be present in higher amount in resistant strains of flax; secondly toxic substances stable to heat which appear to vary in amount according to environmental factors and to the strain of flax.

(5) *Food of the Parasite*:—Many examples of high specialisation in the type of food required are now known among the bacteria and fungi, and Leach (32) has suggested that such specificity of food requirements on the part of the parasite and a similar specificity of food production on the part of the host plant may prove factors in the causation of disease resistance. Coons and Klotz (33) consider that the ability of an organism to thrive in the tissue of a plant will be dependent upon its ability to attack the food substance, especially the protein of the host. Vasudeva (34) was able to show that the fungus *Botrytis allii* Munn. which is normally non-parasitic on apples (in storage) produces definite attack if supplied with a small quantity of nitrogenous nutrient. Giddings (35) believed that food factors were primarily the cause of the development of resistance to rust (*Gymnosporangium juniperi-virginianæ*) in a certain variety of apple. However there does not at present seem to be enough convincing evidence to warrant listing this as a very important factor in disease resistance.

(6) *'Antagonism'*:—In the highest type of obligate parasitism *e.g.*, the rusts, the most susceptible varieties of host plants are those

in which the invaded cells are not killed but remain apparently healthy for a time at least. On the other hand the resistant varieties are those in which the first cells to be invaded by the parasite are killed and apparently form a barrier to the further invasion of the fungus. Ward working with a species of rust fungus (*Puccinia glumarum*) found that in case of susceptible varieties neither the hyphæ nor the invaded cells show any evidence of injury until time for spore formation, while in resistant varieties the invading hyphæ show signs of degeneration. Allen (36) has contributed materially to a more exact knowledge of the factors of rust resistance in wheat. In a comparative study of a resistant and a susceptible variety, Kanred and Baart respectively, to *Puccinia graminis tritici*, she found three factors of resistance in Kanred, namely: (*i*) the hyphæ do not enter the stomata as readily as they do in Baart, (*ii*) when the hyphæ which do enter the substomatal chamber come in contact with the mesophyll cells a reaction is set up which kills the host cell, and one or more toxic substances in the host cell diffuse out of the dead cell and kill the haustoria and hyphæ of the fungus in close proximity, whereas in Baart the haustoria penetrate the cells without apparent injury; (*iii*) the diffusion of the toxic substance into the healthy host tissues immediately surrounding the invaded and killed cells is stopped by the thickening of the adjacent cell walls. Thus there are apparently three different types of factors to which rust resistance in Kanred wheat is due. In another paper Allen (37) describes the results of further investigations of rust resistance exhibited by Baart, Kanred and Mindum wheat to certain strains of the stem rust fungus. In the main, this work confirms her previous work with Baart and Kanred. In susceptible varieties the invaded cells apparently are stimulated to produce a greater food supply for the parasite, whereas in resistant varieties the host cells collapse and soon the haustoria in contact with these cells also die.

(7) *Anthocyans*:—Many instances of the supposed resistant effect of certain anthocyan pigments have been noted in the literature of disease resistance. Red potatoes have been credited with being more resistant than white-skinned varieties. Red apples have been considered more resistant to scab than others. The experimentally proved cases of resistance due to anthocyan pigments are few.

Fromme and Wingard (38) found that varieties of beans with solid red or red mottled seed were resistant to bean rust (*Uromyces appendiculatus*) whereas the white-seeded varieties were susceptible Walker (39) offer convincing evidence that red and yellow-skinned onions are very resistant to onion smudge (*Colletotrichum circinans*) while the white-skinned varieties are susceptible.

(8) *Chemotropism*:—The attempt to explain susceptibility to disease as due to the presence of a positively chemotropic substance in the cells of susceptible plants have been refuted too often to bear much weight. It has been often demonstrated that fungi may penetrate many plants other than their recognised hosts. In such cases, however, the fungi soon cease to grow and the disease typical of their attack on susceptible hosts does not appear. Salmon found that the haustoria of the wheat mildew (*Erysiphe graminis*) penetrated the epidermal cells of the barley but soon died and no mildew symptoms appeared. According to Tisdale the cabbage yellow fungus, *Fusarium conglutinans*, may penetrate the root hairs of flax but never develops far enough to produce a wilt as is the case when the flax plant is attacked by *F. lini*. Gibson discovered that a large number of non-susceptible plants may be penetrated by the germ tubes of several rust fungi but that no further development occurs. Wiltshire (40) noted that the apple scab fungus, *Venturia inæqualis*, could invade pear and the pear scab fungus was capable of entering the apple fruit but neither could produce the disease on other than its own host. These instances indicate that resistance is not a question of inability to enter the host but of inability to develop and cause typical symptoms after penetration has been effected. This may very probably be due to the absence of a positively chemotropic substance in the cells of the host.

(9) *Toxin and Antibodies*:—As yet no definite proof has been advanced of the existence in the attacked plant of specific toxins generated by the fungus itself, or of antibodies generated by the plant, analogous to the toxins and antibodies which are of such importance in the vaccine and serum therapy of the higher animals. Potter (41) showed the formation of a toxic material in the case of the white rot of turnip (*Pseudomonas destructans* Potter) which after

freeing from an enzyme associated with it, prevented the growth of this bacterium on inoculated turnip. Mallman and Hemstreet (42) have been able to isolate an inhibitory substance from a rotten cabbage which was active against an organism from the same cabbage.

Such is a brief review of some of the many factors which may contribute towards the resistance of plants to fungus attack. It is evident that it is most improbable that any single explanation of plant resistance can be adopted as a generalisation covering all types of host-parasite relationship. The nature of plant resistance is clearly complicated and the hypotheses so far advanced are, in general, sufficiently elastic to permit a reasonable explanation of the profound effect which environmental conditions frequently display in determining the degree of attack.

Avoidance of Disease:—A word may be said in this connection about the avoidance of disease. Sometimes it is difficult to distinguish clearly between truly resistant plants and those which might be called 'disease escaping'. Perhaps the simplest cases of escaping or avoiding diseases in plants are those which may be attributed to changes in the environmental factors. During a wet spring and early summer a susceptible variety of apple may develop a high percentage of scab whereas during a dry spring the same variety may develop very little scab. This does not mean that this apple is truly resistant to scab but that due to certain conditions in this particular year it 'escaped' scab infection. Early Ohio potatoes have been found to avoid disease (late blight) by reason of their early maturing habits and an early cowpea escape the Fusarium wilt for the same reason. A variety of wheat which under favourable conditions is quite susceptible to smut, may, in some sections of the country 'escape' smut infection if sown either earlier or later than the usual seedling time.—*"The Allahabad Farmer," Vol. XVI, No. 1, dated January,* 1943.

THE GROWING OF COLD WEATHER VEGETABLES IN NORTHERN INDIA

By W. Burns, C.I.E., D.Sc.,

Agricultural Commissioner with the Government of India

It is possible to grow vegetables of some sort or other in every part of India, but Northern India, including large parts of Sind, the Punjab, the United Provinces and Bihar, is ideal for this purpose in the cold weather. Within this wide geographical belt there are, of course, many differences of soil and of topography for which it is not possible to cater in this short article, which is intended to apply to the so-called 'plains' portion of those provinces. That have a hills' section and to similar areas in other northern provinces. These are mere general hints for the amateur and local conditions may require their modification.

The alluvial soil associated with the Indus and its sister rivers and with the Ganges is a wonderful medium for growing vegetables, but it is not the only kind of soil useful for vegetables. They do, however, demand about two feet of well-drained soil which must be well dug before any planting is done.

Manure to be used

By far the best way is to dig up the land with *kudali* early in the hot weather and leave it rough. In areas where there is not much rain during the monsoon months the soil can be left like this until about August, when it should be thoroughly pulverized and manure worked into it. In other areas, a short crop of maize or brinjals can be taken or a green manure crop, such as sun-hemp or mustard, grown and dug in before it flowers. It is no use putting in coarse, undecayed manure into a vegetable garden. Any manure put in must be thoroughly rotted and pulverized. Such manure can be old farmyard manure which has been in a pit for some time and has been thoroughly broken up and sifted or really good compost which has become fully ripe. Municipal refuse which has been well decayed in a dump may be used. Also scientifically prepared digested sludge from sewage works; but this needs dilution with an equal amount of earth before use. The amount of manure to be given will vary with the known fertility of the soil and with its lightness

or heaviness. A light sandy soil will need more manure and so will a rather heavy clay one. As a rough guide and for medium conditions one cubic foot of well rotted farmyard manure is enough for one square yard of ground. It is necessary to make beds in channels for the supplying of water, assuming that a water supply of some kind is available and can be given from a canal, a well or a stand-pipe. Both water can be used on vegetable garden.

Making vegetable beds

Local *malis* have their own ways of growing vegetables and if they are successful, there is no need to interfere. Longish rectagular beds in which a *mali* can from either side reach over to the middle are probably most convenient, and the space between beds can be about 9 inches broad. The beds want a really good soaking before anything is planted in them as it is no use putting delicate seedlings with their newly-exposed roots into dry soil.

While these preparations are going on, the seedlings have to be raised. In the case of a good many vegetables, it is desirable to raise the seedlings in a separate seed-bed and afterwards plant them out. These seed-beds can be simply smaller plots in which the seeds are sown in lines (so that they may be clearly distinguishable from any weeds coming up) and where they can be very carefully watered by means of a watering-cab with a fine sprinkler. Sprinklers (or 'roses' as gardeners call them) of overseas make may not be available, but a substitute can be made by a local *mistri*. The seed-beds may have to be protected by thorny branches from birds and small animals, but they should not be heavily shaded, as shaded seedlings become weak and leggy and fall over when transplanted. On the other hand, heavy rain in the early stages will throw up soil and batter seedlings to the ground, and a light roof of slates or branches, applied when heavy rain threatens, is useful.

Timing the crops

As one does not want all the vegetables of any given kind coming out all at once, it is desirable to make more than one sowing and to have beds available for transplanting these separate sowings as they come on, *e.g.,* in the case of lettuce, the commencement of sowing can be made as early as August (but much depends on the

nature of the monsoon) and successive sowings can be made at intervals of a fortnight for three months. This gives a succession of fresh lettuce throughout the season. Different vegetables require different distances apart for transplantation and one must judge this from the size these plants are going to be when fully grown. The time to transplant is when the seedlings are big enough to handle but not so large as to have big root systems which would be damaged in transplantation. Here, again, there is a fair range of size within which transplantation can be done. The plant should have at least four leaves and may be from two inches to four inches high.

For transplantation, it is necessary to make a hole with the flat triangular *khurpi* of Northern India. Before transplantation the box or bed in which the seedlings are raised should be thoroughly soaked, so that the seedlings come out easily and delicate roots are not torn. The plants should then be placed in the hole made by the *khurpi* and the soil compacted round the roots with the *khurpi* and the fingers. For cabbages the rows may be 2 ft. apart with 1 ft. 6 in. between the plants; and for lettuce 1 ft. between the lines and 6 in. apart in the lines. Turnip seed is best sown straight into the bed in rows about 1 ft. apart and thinned out to 4 in. in the rows. For cauliflower, sowings can be made once a fortnight during August, September and October and planted out in lines 2 ft. apart with 1 ft. 6 in. between the plants. *Knol khol* or *Khol rabi* can be grown in the same way as cabbage. The seed of carrot can be sown in rows 8 in. apart and the plants thinned out to 4 in. apart. Thinnings can always be used for transplanting in other beds or pieces of ground.

Protection

It is undesirable to have vegetable gardens heavily shaded. A little light shade does no harm, such as would come from a tree with a high top not far off. The vegetable garden should not, however have growing near it or round it any thick vegetation of which the roots would penetrate the vegetable garden soil and steal the plant-food and hence, while some kind of hedge is desirable, it should not be one with widespread roots or one that grows too tall. There are various plants that can be used as hedges, but most of these are merely screens and will not keep out any heavy animal. If

defence against bullocks or dogs is required, then a dry thorn hedge, reinforced by some heavy stakes is the best. If the vegetable garden is in a compound, one should see that the gates (particularly the back gate) are shut at night and that the *chowikdar* is on the alert.

In the early stages of vegetable gardening, a great many weeds will come up, particularly if the soil has only just been taken over from being a lawn or waste ground. These have to be carefully removed by hand in such a way as not to disturb the young vegetable seedlings. Special mention should be made of the methods of cultivation of two very popular vegetables—tomatoes and potatoes. For tomatoes a succession of sowings can be made from August to October and the seedlings transplanted 2 feet apart each way. It is best to sow on ridges and water sparingly and carefully in the intervening furrows. Tomatoes should be fully exposed to the sun. Tomatoes need well-drained soil, and the addition of some crocks, charcoal or masonry rubbish to the soil, when digging and pulverizing it, is useful. The plants must have support, which is best arranged by running lines of coarse string on both sides of each row of plants from sticks at either end of the row and adding more lines as the plants grow higher. Potatoes are planted by putting in the soil small whole tubers or sections of larger tubers (called sets). These are best planted in three-inch deep furrows 18 in. apart. Then the sets should be earthed up and water given in the new furrows made between the earthed-up lines. Potatoes should not be planted in neavy rain or when the soil is soaked and sodden or the sets may rot before sprouting. From the middle of September to the middle of October (the earlier the better) is a suitable time to plant at intervals of about a foot in the furrow.

The onion is not difficult to grow and should be sown about the middle of October direct into the beds in rows 10 in. apart, thinning out the plants to 6 in.

Water required

As regards watering, this can be judged to a large extent by the condition of the plants and the condition of the soil. A good soaking once a week may be sufficient. Other soils may need it twice a week, but soil should not get water-logged, and after an irrigation

when the soil has begun to dry and crack, it should be raked carefully between the plants to form a powdery layer.

As to insect pests, caterpillars should be handpicked and destroyed.

Green-fly (small sucking insects) are best dealt with by spraying twice a week with a tobacco solution with some soap in it Tobacco waste or coarse bazar tobacco (one pound) soaked in two gallons of cold water for 24 hours, strained and made up to four gallons with water plus an ounce of yellow soap shaved down and stirred up with a quart of hot water is a useful spray.—*"Indian Farming," Vol. III, No. 9, dated September,* 1942.

WOOD AS A MATERIAL OF CONSTRUCTION

The present scarcity of metals has focussed attention on the possibilities of timber as a substitute material. And substitutes have a habit of coming to stay. This possible outcome of what at present is forced war-time economy is to be welcomed because timber, quite apart from the shortage of other materials of construction, has received all too little attention in this country. One needs to be reminded that the very word "timber" tells a tale—being derived from Greek and Latin roots meaning "to house", "to build". And while the utilisation of timber as a material of construction and also as a source of food, drink and clothing, as a source of energy and as a source of raw material for a bewildering range of processing chemical industries has made phenomenal advance in other countries, we in India have for the most part not kept pace with these developments. An index of our backwardness in this respect is well provided by our almost complete dependence on imports (which at present are very much restricted) even for such a comparatively simply processed wood product as plywood.

The chief reasons for this state of affairs are our innate conservatism coupled with our ignorance until very recently of even the basic properties of Indian timbers. It was easier to import. And as a direct result of the propaganda on behalf of other materials of construction these later actually made inroads into even the limited

fields where timber thereto held sway. In India, unlike for example in the U.S.A., the Government happen to be the principal owners of timber and in the nature of things could not keep up the same kind and amount of sustained and subtle forms of publicity which competitive materials with powerful interests behind them put forth for the favour of the consumer. It was, therefore, inevitable that timber not only did not make any headway but actually lost ground as a material of construction.

Added to these was another factor which is not peculiar to this country. This may best be described as the psychological factor; for example, such a statement as "timber is not strong" would appear in quite a different light when the weight-strength ratio is considered—weight for weight, a timber could actually be "stronger" than some metals. But this needs to be said and said loudly and often. Again, the drawback alleged to timber that it is not permanent loses much of the point in the light of the modern concepts of economic permanence—that no component of a structure need outlive the usefulness of the structure itself. Anyway, modern methods of preservation have very greatly prolonged the "life" of timbers. Again, while it is true that timber is combustible, it does not follow that it is necessarily the first to give way in any actual fire; metals may also fail at temperatures that are encountered in "fires". And economic processes have been evolved which make timber if not fire-resistant at least fire-retardent. Enough has been cited to indicate the nature of the misconception and half truths associated in the popular mind with timber. Such prejudice and ignorance have been combated in other countries by the twin weapons of educating the public, on the one hand, on the truth about timber and its limitations, and on the other by sustained research which tries to exploit to the utmost the characteristic properties of wood, and, yes, even to improve upon nature by appropriate modifications. The courses on timber engineering in some of the continental engineering colleges and the Timber Development Association in England are classical examples of the first approach to this problem while "Masonite", metal-faced plywood, and "Teco" timber connectors stand out as monuments to recent research in timber.

No greater harm could be done to the cause of timber utilisation than to claim that all timbers are good for every purpose.

Timber is not ductile; it splits easily along the grain; it is not hard enough for some purposes. These are some of the major limitations that must be squarely faced. But timber is light, easily worked with simple equipment to different shapes, easily fastened together, has a comparatively high salvage value and is a poor conductor of heat and electricity, and is susceptible to a minimum corrosion. This is a very valuable combination of properties in a material of construction quite apart from the aesthetic aspect which can, as in interior decoration, become an all-important matter. Timber could be finished to give a variety of attractive effects, while the grain, texture and figure of timber render possible decorative schemes which, for individuality and variety are hard to beat. In short, from the aesthetic point, timber has almost a personality of its own.

There are certain other features in timber utilisation which are of importance in our country. Timber is the material *par excellence* for construction by the villager. Thus, for example, the low first cost and easy workability of timber must be exploited to the utmost in the solution of our rural transport problem. In these areas, the traffic does not warrant the heavy outlay on steel bridges to span the innumerable streams which often maroon entire villages. Treated preframed timber bridges would offer a solution. Suitable type designs could be prepared; and the small timber members going into such a structure could generally be had in the neighbourhood of the site itself. The carpentry and the labour for erection could be provided by the village community itself. The preservative material and the fasteners are the only materials to be imported". Unlike in steel construction, the greater part of the material and labour would be indigenous and thus contribute largely to its total low cost, and keep even this little money within the community. If the traffic should develop beyond the capacity of such a modest structure, or at the end of its normal life—which need be no more than ten to fifteen years—another bridge could easily be built.

In India, institutions designed and devoted to timber research are woefully few And these few are doing pioneer work, often against odds. They can no more than touch the fringe of the problem. But, their work has already succeeded in putting some "condemned" species on the utilisation map of the country, such for

example, is the gradual replacement by indigenous timbers of imported ash and hickory handles. They have done a great deal to educate the public on timber preservation. They have also been directly responsible for the starting of a few timber industries. This should be viewed as no more than a promise of what could be done, Japan, for example, has transformed the humble bamboo into a prime constructional material. The same can and must be done for Indian timbers. Unlike in temperate climates, the number of species in Indian forests are bewildering and neither are the crops homogeneous. The country is so vast that not only do the species differ from region to region but the properties of the same species vary according to its habit. These complications necessitate sustained research in laboratories devoted to forest products and strategically located all over the country. The work of these institutions has to be planned and translated into industrial practice through a liaison agency. And finally the innate conservatism of the consumer and any of his prejudices against timber must be combated by intelligent and sustained propaganda coupled with readily available instruction on the most effective and modern methods of using timber. Such a planned programme does involve considerable outlay. Experience in other countries has proved such expenditure to be good investment. There is no reason to believe that it would be otherwise in *India.—"Current Science," Vol. 12, No. 2, dated February,* 1943.

INDIAN FORESTER

JULY, 1943

THE INDIAN FORESTER

BY SIR HERBERT HOWARD

Inspector General of Forests

Most of us have deplored the falling off in the standard of the *Indian Forester* during the past two or three years. This falling off is natural when so many people have their time more than fully occupied with war work. But to try and improve matters a questionnaire was sent round to the Board of Management and this summary of their opinions may be of interest to general readers of the *Indian Forester.*

There is a general consensus of opinion that every effort should be made to publish the *Indian Forester* monthly even during wartime and even though the peace-time standard of contribution cannot be obtained. Everybody seems to feel that it would be a great pity to interrupt this publication which has gone on since 1875. One or two provinces are prepared to see a 2-monthly or even a quarterly publication rather than a complete cessation but even those provinces consider that every effort should be made to keep up the monthly issue.

In discussing ways and means of providing suitable copy it was pointed out that the editorship need not necessarily devolve on the Personal Assistant to the Inspector-General. But in practice, though the editorship may sometimes be taken over by some particularly enthusiastic officer at Dehra Dun, it is far more usual that there are no such enthusiasts and it becomes one of the many duties of the Personal Assistant. Fairly obviously, that is not the best way to select an editor.

All provinces are opposed to a central board of management consisting of branch officers at Dehra Dun but most agree that some sort of central board of editors is required in addition to the actual editor and in addition to the existing board of management, though most people feel that the present board of management should also continue to function and that the central board of editors or management should be an addition to the existing board of management merely to get down to the actual production of the journal each month. The details of the suggestions for this editorial board vary considerably but practically everyone considers that for practical purposes it must be composed of officers at Dehra Dun though some add that rather than a board of editors it should preferably be one editor with a sort of board of sub-editors.

There is a heavy majority against any sort of payment for articles submitted, though one or two provinces suggested annual prizes for the best articles. Actually such prizes exist in the Brandis Prize and Schlich Memorial prize.

Most people feel that the type of material printed in the journal must be left to the editor and consider that the present description of the *Indian Forester* as "a

monthly journal of forestry, agriculture, *shikar* and travel" is a sufficient indication of its general scope. Except for one province, however, all are emphatic that the journal is a journal of the forest service and should not be allowed to become in any way a publication of Forest Research Institute material which is already published in the normal way by the records, bulletins and leaflets of the Institute. Almost everybody is opposed to "humorous" material though one or two qualified this by saying that they have no objection to humorous articles which are really humorous provided the writer is sufficiently skilled to be humorous without offending against the canons of good taste.

Various miscellaneous suggestions were put forward for improving the general standard and tone of the journal among others that the editor should be paid Rs. 100/- monthly for his trouble.

A sort of Central Editorial Board such as is proposed will now be tried, and, in fact, that Board will no doubt try to give effect to all the proposals for which opinions were fairly unanimous and will doubtless consider all the other suggestions put forward.

SEED DATA OF CRYPTSTEGIA GRANDIFLORA

BY A. L. GRIFFITH

(*Central Silviculturist, Forest Research Institute*)

Great interest has been aroused in the past year in *Cryptostegia grandiflora* as a possible wartime source of rubber. The following data collected in Dehra Dun up to June 1st may, therefore, be of interest to those who have helped in the search for the plant and its seed.

Time of seed collection ... February to May.

No. of seeds per pod ... The average of 10 pods showed 300 seeds per pod.

Seed weight—

Origin of seed.	No. of seeds per oz.
Poona (early collection)	3,280
Poona (late collection)	3,306
Ajmer=Merwara	3,088
Hyderabad (Sindh)	2,656
New Delhi	3,136
Average	3,093

Average number of seeds per lb.=49,500.

Germination per cent.—

Origin of seed.	*No. of Days to* start of test.	*No. of Days to* finish of test.	Germination %
Poona (early collection) ..	6	12	93%
Poona (late collection) ..	12	33	89%
Ajmer=Merwara	9	23	92%
Hyderabad (Sind)	13	25	61%
New Delhi	11	25	78%
Average	11	24	83%

There has been a little trouble with crickets almost immediately after germination, but damage was stopped by spraying with a dilute solution of nicotine. Plant per cent. as judged on those plants that are now fit for planting out appears likely to be from 5 per cent. to 15 per cent. less than the germination per cent.

Six weeks after sowing plants are 2 to 4 inches high and have 2, 3, and sometimes 4 pairs of leaves and look very sturdy. Some 10 days ago temperatures of 109°F and 111°F accompanied by a strong, hot *Looe* wind did not appear to affect the seedlings.

CORPORATE SECURITY OF FOREST EMPLOYEES

By M. D. Chaturvedi, I.F.S.

Summary.—The creation of a Forest Subordinates' Corporate Security Fund will, apart from simplifying security accounts which involve an appalling waste of time in forest offices, instil a spirit of co-operation and *esprit de corps* among forest employees. The proposed scheme in its briefest outline envisages the replacement of individual by corporate security.

The maintenance of security accounts of forest subordinates involves an appalling waste of paper and time entirely disproportionate to the advantage gained. The procedure prescribed has degenerated into a fad and what was perhaps necessary evil devised in the nineteenth century continues to be tolerated because one is apt to follow the line of least resistance. The stage seems to have been reached which justifies an attempt to examine the entire question in the light of experience gained and adjust our ideas of individual to corporate responsibility. The principle underlying the system of individual securities now in vogue is to cover Government against possible loss due to embezzlements. Despite an imposing façade of registers, bonds, postal pass books, interests calculations, monthly deductions of paltry sums and meticulously maintained security accounts, an embezzlement when it does occur must invariably exceed the security of the delinquent to render the deal worth his while. Securities, as conceived at present, have, in the past, only reimbursed a miserable fraction of the loss incurred by Government and provide little else beyond a sense of false security.

Corporate security as outlined here seeks to replace individual security. The scheme, if introduced, will awaken a spirit of co-operation, instil a sense of joint responsibility and inculcate *esprit de corps* among a band of workers all striving towards a common goal. The corporate body of forest subordinates under a

system of joint responsibility will exercise a healthy check on the nefarious activities of a fellow worker, not so much in the interest of Government whom they serve, but in the interest of the body to which they belong. "The individual withers, the world is more and more" should be the motto of Government and the watchword of its employees.

Stated briefly, the scheme contemplate the creation of a security fund to which everybody will contribute a sum of money proportionate to his pay which provides the only measure we have of the responsibility attaching to a post. The fund will deal with all employees of the forest department, whether permanent or temporary.

Once the principle is accepted, details are easy to work out. A basis for discussion is provided by the following draft:

ARTICLES OF ASSOCIATION

THE FOREST CORPORATE SECURITY FUND

1. *Title.*—The Fund shall be designated as 'Forest Subordinates' Corporate Security Fund.
2. *Objects.*—The objects of the fund are to furnish security for its constituent members in the employ of the U. P. Forest Department. All non-gazetted forest subordinates, whether permanent or temporary, holding executive or ministerial posts, will be eligible for membership of the fund.
3. *Constitution of the fund.*—The fund shall be constituted as under:
   Any forest subordinate desirous of joining the Corporate Security Fund shall pay an entrance fee of the sum of money indicated in Schedule I. The entrance fee will not be refundable. On promotion, a subordinate will be called upon to make up the deficiency in his entrance fee laid down in Schedule I.
4. *Administration of the fund.*—The fund shall be administered by an officer not below the rank of a deputy conservator of forests who will be nominated by the Chief Conservator of Forests. U. P., as the Hony. Secretary of the Fund for a period of three years. The secretary shall operate the fund which will be invested in a manner most beneficial to its constituent members in the Imperial Bank of India.
5. *Liability of the Fund.*—The liability of the fund shall be limited to the existing scale of securities given in Schedule I.

SCHEDULE I

Rank	Entrance Fee	Security furnished by the Fund in accordance with scale prescribed.
	Rs.	Rs.
Forest Ranger	20	1,000
Deputy Ranger	10	500
Forester	5	250
Forest Guard	2	100
Head Clerk	10	500
Camp Clerk	6	300
Asstt. Clerks	2	100
Store Keeper	6	300
Surveyors	5	250
Draftsmen	5	250
Telephone Mistrics	5	250
Range Clerks	5	250
Naib Daroga	2	100
Orderlies	2	100
Shooting Guards	2	100
Treasure Guards	2	100
Chowkidars	2	50
Malis	2	50
Mahawats	5	250
Export Moharrirs	2	50
Stump Markers	2	50

Incumbent of any post not provided above may join the Fund by payment of 2 per cent. of the security, provided the minimum entrance fee is Re. 1.

Embezzlement requiring reimbursement of loss of Government from the security of a subordinate have been so rare in the past that a low entrance fee is justified. The U.P. Forest subordinates are reckoned to raise a security fund amounting to about Rs. 15,000 which at 3 per cent. will yield Rs. 450 per annum, which is likely to cover any demand made on the fund, if the records of the past 50 years can be any guide of the future. It only remains to be added that while at present the Government is covered against a loss up to the security actually subscribed by a defaulter, the fund furnishes a security to the full amount prescribed from the very beginning of the service of a subordinate.

To devise a foolproof cast-iron constitution for a fund of this nature is to attempt the impossible. These proposals attempt to provide the merest outline of a constitution which will be perfected in due course by actual impact with realities. Any constructive suggestion will be most welcome.

A NEW TYPE OF CHARCOAL KILN

BY J. SANKARA IYER, B.A.

(*Ranger, Kulathupuzha, Travancore.*)

The State transport department of Travancore, which owns more than 300 buses, are running more than 50 per cent. of their vehicles on charcoal and a major portion of this commodity is being supplied by the forest department either through contractors or departmentally.

Recently I had been to measure charcoal to the transport department in coupe XV-B, Yerur working circle, Kulathupuzha range, and was struck with the simple type of kiln built by coolies from Vilbikari, a village in South Travancore.

The kiln consists of a pit 6 feet square and a foot deep with the sides slanting inwards. Billets of about 5 feet length and up to 20 inches in girth of various species (*T. paniculata, T. tomentosa, Dillenia pentagyna, Pterocarpus marsupium, Lagerstroemia lanceolata,* etc.) are stacked (one way only) in the pit to a height of 2½ ft. to 3 ft. after fire has been started in the centre of the pit and covered above with grass over which mud is put. The mud is spread out and has a thickness of about 6 inches. No water is used. The sides of the stack are covered by twigs with green leaves which allow access of air. No flues are made either around the pit or on the top of the kiln and this omission does not diminish the quality of the charcoal obtained. About ten bags (500 to 600 lbs.) of charcoal are obtained from each such kiln. I am told that 16 to 20 per cent. of weightage used is obtained as charcoal though actual weighing was not done. In a day, the wood is burnt, a day is allowed for cooling and the third morning the charcoal is taken out. Thus the time taken is only 48 hours.

As the same pit can be used again and again, and no water is necessary and no expert labour required, this kiln can be popularised as it is cheap and simple and gives a fairly good percentage of charcoal of good quality.

The coolies are paid 8 annas for a bag of 56 lbs. Each kiln is managed by two coolies and about 200 bags are collected every day in the coupe and taken to Trivandrum to be measured over the transport department.

EXTRACTS

WATER FINDING

BY N. G. APTE, B.AG., M.SC., F.G.M.S.
Water-supply Consultant, 754 Shukrawar,
Poona 2.

The search for underground water is as old as the human race. Ancient myths and legends tell us of this search. The *Vedas* and *Upanishdas* contain references to it in metaphorical language. Some hymns in the *Vedas* purport to direct a thirsty traveller near a particular tree or a particular stone. Realising the supreme importance of water, the *Upanishdas* have so exalted the study of water sources that they promise *moksha* (salvation) to one who studies the subject with special devotion.

Ancient Work on Water-finding.—The oldest work extant is by Varahamihira, a pandit of great eminence in Ujjain, written about 2,000 years ago. It appears to be a resume or consolidation of dispersed material than available. Varahamihira's work contains about 125 verses and gives concisely the results obtained by scientists working in different fields. One of them was Saraswat Muni: the others were a group of workers who were followers of Manu. The observations of these scientists referred, in their own way, to botanical, zoological and geological data. All these were consolidated by the great Pandit Varahamihira in two adhyayas (Chapters 53 and 54) of his famous book, *Sangraharthasuchika.*

This was 2,000 years ago. No definite work seems to have been written later, or if written, is not available. Knowledge of water works, even in the modern sense, by which definite water supplies were developed there was, as can be seen from the works in existence even to-day. Two such works that can be seen in operation to-day are one near Barhanpur and another near Poona. The one near Poona was erected and developed by Nana Pharnavis, the great Minister of the Peshwas. Both are good examples of engineering. Water is impounded and soaked in the soil and is made available at lower levels in wells from which it is taken underground to the place of destination and distributed by piping. No records, however, are available to show how it was done and on what data (geological etc.) it was based.

Water-diviners, *i.e.*, persons who can locate water irrespective of any knowledge of the modern science of water-finding, have played an important part in locating water sources. The records available in this respect are, however, mostly of foreign origin. Europe had many of these water-diviners and there is information about them from the sixteenth century onwards. In Europe the art of divining was well developed and discussed from time to time in several books in various languages. One important publication gives the theories underlying divining. This is *The Physics of the Divining Rod* by Maby and Franklin recently published. A reference to the book was made by Dr. W. Burns in his article on water-divining in this journal (*Indian Farming*, Vol. I, No. 5, May 1940). Diviners in India do not, however, seem to have recorded their observations. Nevertheless, the profession of water-divining is common and is counted as one of the important agencies for locating underground water. Water-divining commands perhaps the most extensive field in the business of water-finding even in this twentieth century.

Literature on the Subject.—Geologists have contributed a great deal to the subject by studying storage and percolation of water, and a very useful book by Frank Dixey gves instructive details about water-supply. Much of his data is, however, from Africa. There is also some very useful information given in the Water-Supply series of bulletins of the U.S. Department of Agriculture. These bulletins are very useful, but the details are from the particular areas studied.

In India the literature on the subject is scanty. Some articles have been published in the *Journal of the Geolcgical and Mining Society of India,* Calcutta. These articles are mainly local studies. The present writer has published some articles in English as well as in Marathi, relating chiefly to the conditions in the Deccan trap area (about 200,000 square miles in extent). He has also published a book, *Maharashtranil Pani Purwata,* in Marathi, originally submitted as a thesis for the *Shastra Parangata* (M.Sc.) at the Maharashtra Vidvapitha. There are useful Government reports, though written for other purposes. The Bombay Department of Agriculture published in 1928 a bulletin (No. 152) dealing with the use of the water-finding machine. That is all the literature on the subject.

Scantier still is the research done in this line. The author worked on the subject for eight years, and incorporated the results in the above-mentioned book. A good amount of work was done on the water-finding machine by several persons belonging to the Department of Agriculture, Bombay and recorded in Bulletin No. 152 of the Department. Following this up, the writer read a paper in 1934 before the Indian Science Congress, giving full details of the working of the water-finding machine (Mansfield and Schmidt).

It will thus be seen that there has been little interest in water-finding in this country. Most of the work done has been confined to the Bombay Province. Part of it was in connection with the water-finding machine and part of it was geological. Most of the geological work was done in the trap area. Observations were also made in the alluvial and granite areas, these being the main formations in the province. It will be noticed, however, that these formations (alluvial, granite and trap) are also the main formations of India and a full study of them may mean a full study of Indian conditions.

Before going into the details of each of the two main methods of locating sites, mention may be made of astrology which, it is claimed, helps to locate underground water. Astrology has very little literature on the subject, and it is perhaps in an indirect manner that some astrologers locate sites. Many of them use the *Sangraharthasuchika* of Varahamihara.

Varahamihara's Studies.—Varahamihara was a great mathematician and scholar, a versatile genius. In his *Sangraharthasuchika,* he gives useful hints on a variety of subjects, including underground water-supply. He devotes 62 verses specially to Marwar. He makes a primary distinction between high rainfall and dry tracts. He points out that the subsoil of the water-bearing area is not of a very impervious nature as in the Konkan districts of Bombay. The verses show his deep observation of the life history and main characters of the animal and vegetable kingdom—observation which is a model for the modern sciences. From the scientific accuracy of his studies, one concludes that Varahamihara was an ecologist. He mentions

such plants as *jambul Ugenia jambulana*), *umber* (*Ficus glamorata*), *shami* (*Prosopis sperigera*), *bor* (*Ziziphus jujuba*) and others. An ecological study of these plants shows that they have one or other of the moisture-saving contrivances provided by nature. All these plants have a deep tap-root. The evaporating surface and the leaves have some such contrivance as a compound leaf, cuticle, fur, oil globule at the mouth of the stomata or fewer stomata. He also mentions another class of vegetation and water-loving plant, namely cane, reeds, *hariali* and others, and finally some characteristics of water-loving insects and animals. Among the insects he prominently mentions the ants that build anthills. They have a tendency to form an anthill near a moist place. Besides this he mentions the snake, the frog and others, which are usually found near water. He mentions that the frog is found underneath the soil or rock. To a layman this is curious. The life-history of the frog, however, clearly explains it. The eggs and larvæ of the frog are very small and since both these stages are passed in water, they can thus get into rock through even a small crack. They grow there as far as the space available allows. The growth is stopped when the space is filled up and it is not able to grow further. Therefore, the presence of a frog is a sure indication of an underground water current.

The depth of the water level is given with reference to two factors, *viz.*, the amount of rainfall and its duration. In a high rainfall tract the greatest depth is about 40 feet. The depth increases to about 100 ft. in Marwar, which is a dry tract. In this case the duration and quantity of rainfall is much less than in the previous tract. This correlation leads to the natural conclusions that all underground water is obtained as rain-water which is absorbed in the soil. Naturally, the quantity available is directly proportional to the duration of rainfall, type and quantity of showers and the absorptive capacity of the soil.

One is full of admiration for this deep study of water-supply, based on sound observation not only of the vegetable but of the animal kingdom and of natural geological conditions. Of all the works on this subject, this study by Varahamihara is the most systematic and thorough. It does not seem, however, to indicate the quantity that may be available. There seems to be one clear reason for this. During his time water was required only for drinking and it is the sources of such water that have been indicated by Varahamihara. He has not touched on or even mentioned the question of irrigation supply. This leads us to believe that the only question that was regarded as essential was that of drinking water. Varahamihara's method is based on definite data and has in certain cases been verified by the present writer under natural conditions while working in various districts.

The most common methods current at present can be put into two classes. By far the most common is divining. The scientific method, though fully rational, is not so popular. For this reason scientifically trained men are not numerous and are not easily available. Experience gained in the Province proves this. Even with four water-finding machines and operators, the demand for testing with the machines the sites located by diviners could not be met. Let us consider divining first.

Divining.—Divining as popularly understood is an innate intuitive ability to locate water by some feeling which the diviner is not generally able to explain.

This is supposed to be some supernatural power, whereas it is really the susceptibility of the person to certain influences. Such persons when passing over currents or pockets of water feel its presence. Diviners also indicate precious metals. The type of feeling obtained in the case of precious metal is, however, different. Many do not use instruments; some use instruments such as a plum bob or a forked T or Y-shaped iron rod; some others use fresh branches of similar shape, or two sticks attached to a wooden cone to make an artificial divining rod. It will thus be seen that quite a variety of instruments are used. Those who do not use them have some other individual peculiarities: some require an absolutely calm and cool atmosphere, some would worship at a particular place, and so on. If one inquires of these persons how they locate water, some explain that they hear peculiar sounds, while others state that they receive shocks, or experience a peculiar feeling. Those who use the rod tell us that the rod bends on a current. The direction of movement may be either upward or downward. In some cases, the rod moves upwards or downwards for the same indication when held below or above the hips. There is again a class of diviners who do not need instruments nor do they have any special worship: they simply feel the presence of water. Thus it will be seen that there is every variation of method in divining.

There is a large class of water-diviners of all descriptions. Naturally there are numerous quacks and impostors, and it is difficult to distinguish between the *genuine diviner* and the quack or impostor. The writer remembers a beggar girl who indicated the best spot of the locality when he was working with the automatic water-finding machine. This incident occurred when the writer was searching a dry area in the Satara District with an automatic water-finding machine and had already tested half a dozen sites. The girl asked what the machine was for, thinking it was a camera. It was explained to her that a search for water was going on as there was scarcity. She then pointed an altogether different site. This was tested with the automatic water-finding machine and it gave better results as compared to the previous sites tested by the machine. When asked, the girl explained that she had a feeling that there was water at the place she had indicated. She could not explain further.

No data, however, is available as to the success of such divining and hence it cannot by systematized. The Government of Bombay employed the services of a water-diviner and had a regular record. The writer had occasion to test his sites with the automatic water-finding machine. There is also a report of his work but unfortunately, that does not speak well of the divining method. The percentage of success is much less than 50 and is not, therefore, encouraging.

Writer's Divining Power.—The writer experiences a feeling in the calf when passing over a spring or a slight pain when passing through river-beds. He gets this feeling on rainy days also. It was not known that it had any relation with the underground water-content till 1933. In 1926 the writer first tried to operate the automatic water-finding machine at a village named Katarkhatav in the Satara District. Five different plots and 30 different sites were tested. In one field he felt a pain in the calf. Later on a report of the readings on the water-finding machine was made to the officer who interpreted the readings and decided that the field

(where the writer got the pain in the calf) contained the best water supply. Such cases multiplied, but the author did not realise (till 1933) that he possessed this capacity and that the peculiar kind of pain was an indication of underground water. Being a believer in modern science and engaged in chemical and geological research, the occurrence of this pain was taken to be an effect of the weather or of indifferent health.

All this, however, goes to prove that divining powers do exist and that it is possible that some may feel and others may hear or get a movement of the rod or other material they use indicating the presence of water. Naturally there cannot be any exact measurement of these powers and so there is the possibility of quacks and impostors getting in and posing as real diviners. The need, therefore, arises for choosing the right man, and the only criterion is the result of his advice. The stray results of diviners that are available are not, however, very encouraging. Besides, the human factor is affected by various circumstances. The one of remuneration is naturally of very great consequence. This factor causes nervous disturbances and upsets the tone of the whole body and makes it unsuitable for any good work. The health factor also is of equal importance. If these factors are taken care of, the results can be reliable. But this is very rare. The author can say from personal experience that when the body is not in proper order (nervous or physical) the "feeling" of the current is affected. That is why the results of professional diviners do not come up to 100 per cent. As a matter of fact, the results of divining should be 100 per cent. correct. The reasons of failure are obvious. The diviner has to be left to himself and asked to state his own remuneration and to choose his own time and day for 100 per cent. results. Given these facilities, a genuine diviner may produce correct results.

With these limitations the method of divining is as real and successful as that of the geologist coupled with the water-finding machine. The theory of divining can be vouched for and the results guaranteed if a real diviner can be procured. One can say from experience that there is nothing unreal or mystic about a genuine diviner. The genuineness, however, is a matter of personal integrity.

Geology and the Water-finding Machine.—The other method is that of the geologist, coupled with the automatic water-finding machine. A merely theoretical geologist is of no use. He must possess other useful knowledge such as the rainfall of the area, the temperature prevalent, the gradient of the locality, the general conditions as to absorptive and retentive capacity of the surface soil as well as sub-soil. He should also possess supplementary information such as the natural water currents in the locality and their relative position as to levels, etc., as well as storage, natural or artificial, if any. He should in short, have a full knowledge of the factors that affect the total underground water-supply in the locality under examination so that he may be able to make a definite conjecture about the existing water contents and their probable situation. This having been done, the water-finding machine is the best appliance for checking the theoretical conclusion of the geologist. This method seems to be much more definite. One very important factor is that every item of this method depends on certain natural laws. A shower of rain falling under certain conditions of rainfall and temperature, soil and sub-soil conditions and gradient will

have a definite quantity of percolation underground and a definite retention. These have been established by definite studies and any one can learn them, correlate them and draw conclusions. The water-finding machine used to corroborate these conclusions has also its own limitations of climate as well as others. These limitations are briefly as follows:

The machine should not be operated in damp and moist places and should not be placed near trees or big buildings. It is affected by electric currents and by iron. Big girders and iron structures are, therefore, to be avoided. A cloudy and overcast sky affects the readings and at times cancels them out altogether. This is according to the makers. While working with the machine in the Deccan trap area, the writer noticed that the machine did not give reliable indications when the atmosphere was very cold or very hot. The approximate time of working during the day was therefore $1\frac{1}{2}$ to 2 hours. On cold days work had to start late.

The soil temperature should be a guiding factor while using the automatic water-finding machine. It has been noted that when the soil temperature rises above 100°F. (or 38°C.) the readings obtained are incorrect. The same is the case with lower temperatures when the temperature falls below 85°F. (or 29°C.); then also the readings obtained are not reliable. The above statement about soil temperatures is approximate and is a result of observations made during the last fifteen years, while working with the automatic water-finding machine of both types—Mansfield and Schmidt.

Merits of Water-finding Machine.—In passing, a few words may be said about the machines themselves. There are two patterns, Schmidt patent and Mansfield patent. They are similar in working except for the exterior form. The Schmidt pattern has a round glass fitted to the upper chamber on the side that is to be directed towards the north. Thus the observer has to observe the readings from the north in this case instead of the south as in the case of the Mansfield pattern. Of the two patterns the writer has found that the Mansfield gave better work and was more sensitive to water currents. The machines are worked on the theory of vertical earth currents. There was no chance, however, of verifying the theory, but the results obtained over a range of 25 years justify the basis of operation laid down by the workers in Bombay. The writer worked with the machine from 1926 onwards and it can be stated as a matter of experience that the water-finding machine, if used with the knowledge of the limitations enumerated above, and if the readings are interpreted properly on the basis laid down by Rao Bahadur Dr. D. L. Sahasrabudhe, formerly Agricultural Chemist to the Government of Bombay, gives reliable results. This is the writer's experience. The results obtained from the machine have been stated in the bulletin of the Department of Agriculture of the Bombay Presidency.

Some people believe that if they have a machine they can get results. This belief is not correct as some Indian States have realised after investing in the machine. It is the operator of the machine, equipped with geological information and a full knowledge of the use of the machine who can reliably advise on the underground water contents of a locality. The machine by itself in anybody's hands cannot give reliable results.

It will thus be seen that this method also has its own limitations. The availability of persons competent to operate the machine is also restricted. The method, however, as stated, has given reliable data and can be systematised by further work. The question of underground supply is not so keen in the alluvial area as it is in the Deccan trap or granite areas and one finds in the latter areas hundreds of wells without sufficient water. Everyone of these useless wells stands as evidence in favour of a further study of the problem so as to obtain a method for full and unfailing scientific guidance. Most of these wells tell us of the failure of one diviner or another or at times of an unskilled water-finder. The problem, therefore, has to be studied further at least for the non-alluvial area and the knowledge of geology coupled with that of the water-finding machine has to be made so common as to be within the reach of the poor cultivator of the country.—*Indian Farming*, Vol. III, No. 12, dated December, 1942.

SOME FORESTS I HAVE KNOWN

By E. P. Stebbing

The first type of tropical forest I ever went into was the *sal* (*Shorea robusta*) region of Chota Nagpur, situated in the extreme west of the old Bengal Province, before Bihar and Orissa had been lopped off to form separate provinces. The chief district of Chota Nagpur, from the forest point of view, was Singhbhum. The eastern half of this was chiefly agricultural land, mostly rice cultivation, interrupted with low rocky hills covered with a scattered more or less open high scrub forest which spread out into the flat land, the rocky hills being the home of the Indian bear; and many lively times we had in beating him out of his home in the caves to which he retired for a *siesta* in the daytime after his night foray into the fields. The western half of the district where the forest officer chiefly ruled was very different. It consists of great stretches of primeval *sal* at the lower levels, which opened out and had a more stunted growth as one climbed up the rocky hillsides. Saranda they called this region, which means the country of the "Seven hundred hills." At the time I first knew it this area was visited in the outer accessible parts by the forest officer and a few others attracted by the sport it offered, of which the cream was tracking on foot the old bull bison over hill and dale in the hottest part of the year. The local indigenous tribes were adepts at tracking. The *sal* forests were not pure. Perhaps the chief associates were *Terminalia tomentosa, Eugenia, Diospyros, Strychnos, Bassia, Schleichera, Bmbax* and *Ficus,* and in the bottom of the narrow valleys thickets of bamboo (*Dendrocalamus strictus*). Here, in the heat of the day, you might run into your old bison—and not uncommonly lose him.

It was a great change for a young forest officer to find himself suddenly switched from his first love up to the Eastern Himalaya out east of Darjeeling in British Sikkim. In the summer capital of Bengal, Darjeeling, the tree chiefly seen is the *Cryptomeria japonica*—an exotic which has replaced the old indigenous forest, cut out with the growth of the station. The forests on this side of the Himalaya are quite different to those of the west. There is much more moisture in the air and a longer monsoon. You find so-called oaks, *Bucklandia,* chestnuts, magnolias and *Cedrela.*

In the Sikkim forests the chief genera are two species of oak, four chestnuts, six of magnolia, maple, walnut and *Bucklandia*. And the trees had long, waving grey lichen banners hanging to their boles, giving the forest a ghostly appearance. My charge—it was my first independent charge—took me to the foot of the Himalaya. Here, at the lower levels the *sal* tree held sway in mixture with a mass of tropical vegetation of tree ferns, plantains, many climbers, orchids—a wonderful forest to see, if inevitably malarious. Except for the *sal* there was scarcely a tree genius or species which I had known in Singhbhum. So there was plenty of interest and plenty to learn. At the lower elevations above the *sal* in Sikkim grew the pine (*Pinus longifolia*) with higher up the genera already enumerated; whilst at the upper levels of the forest line was found the Silver Fir. It was a queer flora approaching the change which takes place farther to the east. I should have added that at elevations of 6,000 feet or so and above, the Sikkim rhododendrons made the most gorgeous of pageants when in flower. covering whole mountain sides. My district here ran on to the frontiers of Nepal, Tibet and Bhutan. I made one brief descent into a valley of forbidden Thibet in the hopes of bagging the wonderful Sikkim stag, but had no luck and could not remain.

It was a far cry from the North to the extreme South-East of Bengal, which took me to Chittagong on the Bay of Bengal. A huge charge consisting of some five forest ranges out in the district, with shrub forest, bamboos and coarse grass on low hills, all of great local value; and away up in the Hill Tracts (which to the north borders on South Lushai of the Assam Province) some 4,000 square miles of a tropical type of forest in which I did not know a single species of tree, except from lecture notes in what appeared a remote past (about four years); in fact only the bamboo was recognisable. In this great agglomeration of trees, amongst the chief genera were perhaps *Jarul* (*Lagerstrœmia flos-Reginæ*), a very fine timber, *Artocarpus, Dipterocarpus, Mesua, Cynometra, Garcinia* and *Cassia*.

The whole, or nearly the whole, of my work was on the rivers. All the chief produce from the Hill Tract forests was floated down the rivers in great rafts of logs, usually including several dug-out canoes (whole trees with the interior burnt out), or even longer rafts of bamboos. These rafts had to tie up at the Forest Toll Stations, at which the Government revenue on them was collected. Shifting cultivation was practised up in the Hill Tracts, and was annually becoming more harmful. Several expeditions I made up in these parts and a very wonderful forest it was. It can't be dealt with here. If I started it would take all *Sylva*. I may mention that the other Indian bison, called the *mithan*, lives here, and affords fine, if arduous, sport—tracking on foot once again.

I left Bengal and went up North-West to the United Provinces (then called the North-West Provinces) and Dehra Dun, even at that time more or less the headquarters of Indian Forestry. All along the foot-hills of the N.W. Himalaya up to about 2,000 feet or so and out into the plains for a certain distance you have *sal* forest, the same type as I had known in Chota Nagpur. Here, however, there was a longer cold weather season, and the hot weather was not so fierce as in the former. The *sal* forests here had been under management almost from the beginnings of the Forest Service, *i.e.*, the early sixties of last century. And certainly they

looked very orderly to eyes which had only seen the wild untouched Saranda and the equally wild regions of the Himalayan Sikkim forests and these of the Chittagong Hill Tracts. A noticeable thing here, however, was that the *sal* forests had an undergrowth of high tiger grass, 10 to 12 feet high, which necessitated your going about on elephants to get through the forest. This is equally true of the plains forests at the foot of the Eastern Himalaya which stretches from Bengal into the Assam Province, which I subsequently visited more than once; though there the *sal* is growing in a moist heat instead of a dry hot climate, showing the adaptability of the species.

These U.P. plains and sub-mountane forests besides *sal* include *Terminalia tomentosa*. Huldu, Khair (*Acacia Catechu*), Sissu (*Dalbergia*), *Diospyros* and other species to form the mixture; with the bamboo brakes in the valleys and the gorgeous climate of the cold and hot weather they were a wonderful place for the Forest Officer—full of the game—deer of several species, tiger and leopard, and boar—and as near Paradise in the plains of India as you were likely to get.

But this was not all. For here you were on the fringe of an even more delectable region—the great coniferous and oak forests of the N.W. Himalaya. Above the *sal* belt great stretches of pure *Pinus longifolia* clothed the lower mountain sides up to some 6,000 feet. Then came the glorious deodar (*Cedrus Deodara*) and the blue pine (*P. excelsa*) in pure and mixed blocks with areas of hardwoods of three oaks, *Quercusincana, dilitata,* and *semi-carpifolia*, the latter running up above the deodar line of about 6,500 feet to 9,000 feet odd, where it ran through the great masses of Silver Fir and Spruce forest which clothed the hills up to the snow line at 14,000 feet or so.

No one who has not known them can dream of the delights of these Himalayan Forests or of the fragrance in the early morning when quitting a Rest house one starts off for a long day! And the mountain sheep and goats live up here—also the bears! Plenty of sport.

The famous teak forests of India and Burma present a very different picture. In India the teak is confined, if we omit plantations, to the Western half of the Central Provinces, Bombay and Western Madras including the Native States of these regions. The tree is usually in mixture with other species, but on occasions as in the case of the *sal*, is inclined to be gregarious. I remember the first time I ever saw the teak forest in flower. It was during the rainy season in the Central Provinces. I stood on a hill-top looking across a bit of a valley. On the opposite range of hills as far as the eye could reach was a great mass of what looked like frothing white foam. It was the great panicles of the bloom of the trees—the great teak forest was in flower. Never had I seen such a sight. But to see the teak forest in its glory, Burma must be visited. Here the uninitiated will at first be little the wiser. Standing below, the veriest pigmy, in a great forest mass in which three storeys of trees may be visible of species of genera as *Hopea, Pterocarpus, Cedrela, Dipterocarpus, Xylia* and many others he won't even then, if he knows the tree, see any teak. He will soon, however, be shown a great buttressed column, and may or may not get a sight of its lofty crown away up above the other canopies. It was

the late Professor Troup who first showed me that picture in a Burma teak forest. Often, however, the lower storey in the forest consists of a dense mass of some of the fine Burmese bamboos, and you won't see much else.

Here in parts of Burma and also on the Western side of Madras is the Evergreen Forest which, as its name implies, is never leafless. Wonderful trees you have in this type, enormous specimens of *Artocarpus* and *Calophyllum* with *Hopea, Acrocarpus, Terminalia* and others with buttresses each enclosing the space of a small cottage and a riot of tropical vegetation of all types.

Along this coast from the Sundarbans south of Calcutta, noted for its tigers, down to Rangoon, Moulmein, and on into Siam and Malaya, etc., there is that curious type of forest known as the Mangrove Forest, its home in the muddy tidal channels of the deltas of the rivers (also in West Africa and elsewhere). An appalling forest to walk through—wide waterways with a rapid current ebbing and flowing with the tide; mud banks into which you sink at every step; at high tide large tracts under water, too deep to walk in; small creeks only get-at-able at high tide; and above all and most unpleasant on the so-called land, even at low tide, a mass of aerial roots sticking up close together like so many spikes. Amongst the chief genera are *Heritiera, Rhizophora, Ceriops* and *Sonneratia*.

India can also show various types of desert forest formations from that containing low branched trees, *Prosopis, Zizyphus*, etc., to open scrub, finally degenerating into thorny brushes, in regions, too, which history relates as having been covered with forest. (*Vide* the campaign of Alexander.)

It seems a long distance from the lovely deodar forests of the north to the south of Madras, where wild elephant and bison roam the forests, but my next type of forest is still farther away. Travel to Archangel in North Russia, go aboard one of the river steamers and go up the Northern Dvina River some 400 miles, change into a smaller ship and continue up one of the tributaries to the foot-hills of the Urals. Some 80 miles after leaving Archangel you will only see forest with an ever narrowing ribbon of cultivation on the river bank which is by no means contiguous. The rest is forest. Miles, hundreds of miles, and many millions of acres of, save in the parts nearest to Archangel, nearly untouched virgin forest of Scots Pine, Spruce and Birch—containing some of the finest red and white soft woods extant in the old world. This forest has to the north a band of up to 50 miles wide of the tundra—a desolate peaty waste with scattered dwarf spruce and pine and may be a few birch here and there on its forbidding surface. Beyond is the Arctic Ocean, and much of the area I am alluding to is within the Arctic Circle. When up in these regions it was difficult to realise one had ever lived in, and at times heartily cursed, the tropical forest.

And what of the West African types? The Rain Forest, evergreen and so dense that you can't see into it more than a 10 yards touchline scrum. The most valuable timbers are the giant *Mahogany, Khaya;* scented mahoganies, *Entandrophragma* and *Gaurea;* the pink mahogany introduced to me in Nigeria by Kennedy (an old student) as the champion in botanical nomenclature—to wit *Gossweilerodendron balsamifera! ; Lovoa, Afzelia, Triplochiton.* The Deciduous Forest, behind and inland of the Rain Forest, a type much resembling its Indian counterpart, except for

the genera represented here by *Chlorophora* (Iroko, also in Rain Forest), *Mansonia*, species of *Khaya*, *Triplochiton* and many others. Northwards follow the great areas of the so-called African bush or savannah which, with a height of some 30 to 40 feet or so, and a canopy which, though broken, can still be regarded as a forest type containing *Isoberlina*, *Chlorophora*, *Khaya*, *Anogeissus*, *Dalbergia*, etc., till it degenerates to the north into a scrub which contains, however, species of *Combretaceæ* *Bauhinia*, *Parkia*, *Prosopis*, the *Baobab*, and *Acacia*, the latter producing the valuable gum used in the manufacture of the best chocolate in this country; this scrub finally becomes more and more open and degraded, and in the southern approaches of the Sahara is no more than a lot of thorny bushes—resembling, again, what are to be seen in the desert regions of Rajputana and the Punjab in India. Much of the bush to the south is similar to what I had known in the eastern half of the Singhbhum district in India.

I would have liked to add a few remarks on some of the more out of the way other European forests I have seen, but space prohibits. The Hon. Editor asked me for 2,000 words. I was aghast! But expect I have exceeded them.—*Sylva*, 1942-43.

INDIAN FORESTER

AUGUST, 1943

SOME COMMON LATEX-BEARING WOODY PLANTS OF INDIA

BY A. L. GRIFFITH, *Silviculturist,*

and

K. L. BUDHIRAJA, *Rubber Chemist,*

Forest Research Institute, Dehra Dun.

The discovery that the latex of certain plants, when dried, yields an elastic and resilient substance is fairly old though the use and application of such substances was not known or made till the middle of the last century. Perusal of the literature shows that *Ficus elastica* was one of the earliest of the rubber-yielding plants to attract attention. Its product known as "Assam or India rubber" was commercialised, at one time, but was soon superseded by a better product, "para" rubber, from *Hevea braziliensis*. After the introduction of para rubber some 40 or 50 years ago, interest in all other rubber-yielding plants declined very rapidly with the result that information on rubber bearing species other than *Hevea* is very meagre and in many cases absent.

The war has created new and abnormal conditions necessitating the exploration of all plant materials, woody or otherwise, which might turn out to be alternative or additional sources of rubber. With this object, the examination of possible rubber bearing woody plants has been undertaken at the Forest Research Institute at the instance of the War Resources Board, India.

As a start, the silviculture branch went through all available sources of literature and ledger files and put together information on many of the plants that had attracted the attention of rubber seekers. The result was the Indian Forest Leaflet No. 22 (silviculture) "Possible war-time sources of vegetable rubber in India," which was published in June, 1942. Next, the silviculturist and botanist got together and made up a list of all the plants which were either already very common in India or which could be grown quickly and which might possibly produce emergency rubber. Then an appeal was sent to all the forest departments and particularly silviculturists to send us samples of the latex of all these species so that a rapid preliminary survey by actual analyses of the latices could be carried out by the chemistry branch. The result of this appeal was immediate and samples of latex together with botanical specimens of the species from which the latex had been obtained began to pour in. They were sorted by the silviculturist, the botanical specimens were checked by the botanist and the latices were analysed by the chemist. The co-operation and response was so good that in six months we have received 140 latex samples covering five families and 43 species and have examined 75 samples covering all the families and species concerned.

Everyone who has helped in this work is naturally anxious to know how it is progressing. Further, it has been impossible for us to keep all districts or even provinces up to date with this investigation that has moved so fast. Without the active cooperation of the forest departments through the length and breadth of India the work would not have been possible and this note is, therefore, written as an interim record of what has been accomplished so far (up to June 1st, 1943). With the multiplicities of war jobs the local forest officers have their hands more than full and we realize what constantly asking for "samples of milk," often from plants not well known in ordinary forest work, has meant. We, therefore, hope that this note will convey to individual officers how they have helped in the preliminary investigation and how much we need their help in the more specialized work now in progress.

Apart from *Hevea* and *Ficus elastica,* the plants given in Table II are some of the other important sources of natural rubber but neither are they indigenous to India nor do they grow in countries from where the rubber could be made available to India for her defence purposes. This has made the desirability of exploring new sources ever so much greater than before.

From the analyses so far done, indications of possible sources of rubber have already been obtained. The results are tabulated below:

TABLE I

Species	Place of collecting latex.	Percentage in coagulum			Percentage in original sample or latex	
		Caoutchouc	Resins	Insolubles	Water and water solubles in original latex	Caoutchouc in original latex
			APOCYNACEAE			
Alstonia scholaris ..	Yellapur (Kanara) ..	19.1	73.4	7.5	84.7	2.9
Do. ..	Rajendrapur (Bhowal) ..	12.9	78.7	8.4	78.5	2.8
Do. ..	Dhoni, S. Malabar, Madras ..	17.9	76.5	5.6	72.3	5.0
Do. ..	Periya, Wynaad, Madras ..	26.5	69.0	4.5	70.3	7.9
Holarrhena antidysenterica ..	Godhra Panchmahals, Bombay	15.0	82.8	2.2	83.8	2.4
Do. ..	Palamau, Bihar ..	17.3	76.8	5.9	91.1	1.5
Plumeria acutifolia ..	Coorg ..	19.1	62.7	18.2	83.3	3.2
Do. ..	Palghat, Madras ..	16.1	75.6	8.4	84.4	2.5
**Thevetia neriifolia* ..	Bhatli (Orissa) ..	13.3	69.7	17.0	54.8	6.0
**Tabernaemontanea heyneana* syn. *Ervatamia heyneana*	Coorg ..	24.0	75.0	1.0	80.0	4.8
* Do. ..	Kudra, Kanara, Bombay ..	23.7	75.6	0.7	64.1	8.5
**Wrightia tinctoria* ..	Kalyan, Nasik, Bombay ..	17.1	68.9	14.0	71.0	5.0
**Wrightia tomentosa* ..	Mendabari, Buxa, Bengal ..	22.6	76.4	1.0	62.7	8.4

Species.	Place of collecting latex.	Percentage in coagulum.			Percentage in original sample or latex.	
		Caoutchouc	Resins	Insolubles.	Water and water solubles in original latex.	Caoutchouc in original latex.
	URTICACEAE.					
Artocarpus integrifolia ..	Kolaba, Bombay ..	10.0	82.6	7.4	71.3	2.9
Do. ..	Yellapur, Bombay ..	6.0	85.9	8.1	68.9	2.5
Do. ..	Jalpaiguri, Bengal ..	9.7	86.4	3.9	76.0	2.3
Do. ..	Rajendrapur, Bhowal ..	5.3	59.1	35.6	76.2	1.3
Artocarpus hirsuta ..	Yellapur, Kanara, Bombay..	6.6	91.4	2.0	59.6	2.7
Do. ..	Coorg ..	7.1	87.0	5.9	70.6	2.1
Artocarpus lakoocha ..	Yellapur, Kanara, Bombay..	12.2	82.8	5.0	68.8	3.7
Chlorophora excelsa ..	Kannoth, Wynaad Dn. Madras (chloroform extract)	0.9	77.5	21.6	67.2	0.3
**Ficus altissima* ..	Kannoth, Wynaad, Madras..	17.6	79.7	2.7	71.3	5.1
F. asperrima ..	Yellapur, Kanara, Bombay..	nil	2.3	97.7	86.9	nil
F. bengalensis ..	Rungkud village, Bihar ..	15.9	82.2	1.9	77.9	3.5
Do. ..	Kolaba, Bombay ..	13.8	83.5	2.7	65.9	4.7
**F. glomerata* ..	Rungkud village, Bihar ..	25.7	72.3	1.9	71.3	7.4
F. infectoria ..	Yellapur, Bombay ..	6.9	90.6	0.5	57.2	3.0
F. nervosa ..	Yellapur, Kanara, Bombay..	4.8	65.5	29.7	89.3	0.5
F. retusa ..	Belgaum, Bombay ..	2.3	86.9	10.8	92.4	0.2
F. cunia ..	Saranda, Bihar ..	10.0	77.2	12.8	90.3	1.0
F. carica ..	Palampur, Punjab ..	7.2	55.4	37.4	66.1	2.4
F. religiosa ..	Hyderabad, Deccan ..	5.3	82.1	12.6	86.4	0·7
Do. ..	Barapahar, Dn., Orissa ..	7.1	74.9	18.0	34.6	4.67
Do. ..	Multan, Punjab ..	6.7	75.8	17.5	23.5	5.12
F. rumphii ..	Bombay ..	19.2	78.7	2.1	64.0	6.9
F. talboti ..	Belgaum, Bombay ..	7.6	81.5	10.9	87.9	0.9
	ASCLEPIADACEAE.					
Calotropis gigantea ..	Kolaba, Bombay ..	13.0	79.7	7.3	86.8	1.7
Do. ..	Panchmahals, Bombay ..	5.1	84.1	10.8	88.9	0.6
Calotropis procera ..	Multan, Punjab ..	15.8	71.1	13.1	92.4	1.2
Do. ..	Karachi, Sind ..	11.4	85.0	3.6	93.0	0.8
Do. ..	Haldwani, U. P. ..	19.8	80.2	nil	88.4	2.3

Species	Place of collecting latex	Percentage in coagulum			Percentage in original sample or latex	
		Caoutchouc	Resins	Insolubles	Water and water solubles in original latex.	Caoutchouc in original latex.
**Cryptostegia grandiflora* ..	Poona, Bombay ..	86.0	8.3	5.7	73.4	22.9
Do. ..	Multan, Punjab ..	79.8	12.5	7.7	82.1	14.3
Do. ..	Rajputana, Punjab ..	81.9	11.5	6.6	73.0	22.1
Do. ..	Dehra Dun ..	80.0	16.8	3.2	84.4	12.5
Do. ..	Delhi ..	88.0	11.6	0.4	87.4	11.2
Do. ..	Coimbatore (Madras) ..	86.4	12.3	1.3	82.9	14.8
**Cryptolepsis buchanani* ..	Dehra Dun ..	11.8	72.6	15.6	47.1	6.3
		(probably gutta type)			(probably gutta type)	
	SAPOTACEAE.					
**Bassia latifolia* .. (syn. *Madhuca latifolia*)	Medak, Hyderabad, Deccan	19.9	55.9	24.2	58.2	8.3
Do. ..	Mandvi, Thana, Bombay ..	18.0	63.3	18.7	62.1	6.8
**Dichopsis ellipticum* .. syn. *Palaquium ellipticum*	Coorg. ..	24.9 (gutta type)	63.5	11.6	56.7	10.8
Dichopsis polyantha ..	Chittagong hill tracts, Bengal	21.2	47.9	30.9	67.9	6.8
	EUPHORBIACEAE.					
Euphorbia antiquorum ..	Coimbatore, Madras ..	18.0	65.1	16.9	77.8	4.0
Do. ..	Dharwar-Bijapur, Bombay	23.7	62.8	13.5	73.2	6.4
E. neriifolia ..	Thana, Bombay ..	6.2	70.4	23.4	82.5	1.1
Do. ..	Ranchi, Bihar ..	13.3	85.0	1.7	80.3	2.6
E. nivulia ..	Karachi, Sind ..	8.9	78.5	12.6	92.1	0.7
E. tirucalli ..	Dharwar-Bijapur, Bombay	11.0	80.2	8.8	65.8	3.8
Do. ..	Panchmahals, Bombay ..	14.1	77.0	8.9	79.9	2.8
E. royleana ..	Dehra Dun ..	11.8	63.8	24.4	74.7	3.0
Do. ..	Haldwani, U. P. ..	5.0	75.5	19.5	80.5	1.0
Do. ..	Agra, U. P. ..	12.6	77.1	10.3	77.2	2.9
Excaecaria agallocha ..	Sunderbans, Bengal ..	8.8	65.4	25.8	69.4	2.7
Excaecaria robusta ..	S. Coimbatore, Madras ..	7.3	75.7	17.0	73.5	1.9
Jatropa curcas ..	Ranchi, Bihar ..	nil	14.6	85.4	96.0	nil
Manihot glaziovii .. (Ceara rubber)	Kannoth, Wynaad Dn. Madras	92.5	4.3	3.2	80.3	18.3
**Poinsettia pulcherrima* .. (full grown plant)	Dehra Dun ..	30.2	66.2	3.6	78.6	6.4
Do. ..	Do. ..	32.9	62.2	4.9	78.9	6.9
Do. (middle-aged stems)	Do. ..	32.5	63.0	4.5	84.8	4.9
**Poinsettia pulcherrima* .. (very old stems)	Do. ..	33.5	62.7	3.8	82.9	5.7
Sapium insigne ..	Kanara, Bombay ..	8.0	53.3	38.7	76.6	1.9

TABLE II.

IMPORTANT SOURCES OF COMMERCIAL RUBBER

Species.	FIGURES OF ANALYSES ARE GIVEN ON ZERO MOISTURE BASIS.				REMARKS.
	Caoutchouc	Resins	Proteins	Ash	
Hevea braziliensis (EUPHORBIACEAE) ..	95·4	2·7	1·8	0·15	*Para rubber.*—A native of the Amazon. Planted in many tropical parts of the world. It is a source of 90—95% rubber produced in the world.
Manihot glaziovii (EUPHORBIACEAE) ..	78·8	10·4	8.3	2·5	*Ceara rubber.*—A native of Brazil. Now grown in Ceylon, India and other tropical countries.
Castilloa elastica (URTICACEAE) ..	86·4	12·5	0·9	0·2	*Panama rubber.*—A native of Mexico and Central America.
Ficus elastica (URTICACEAE) ..	84·7	12·0	2·4	0·9	*Assam or India rubber.*—A native of Northern India and Malaya.
Funtumia elastica (APOCYNACEAE) ..	86·9	9·1	3·4	0·6	*Lagos silk rubber.*—A native of tropical West Africa.
Landolphia kirkii ..	76·6	12·8	9·4	1·2	*African rubber.*—Native of West African coast. Cultivation is impracticable owing to the habit of the plant.
Landolphia owariensis (APOCYNACEAE) ..	90·6	6·2	0·9	2·3	
Parthenium argentatum (COMPOSITAE) ..	Cultivated American 7-10% on plant.				*Guayule.*—A native of Mexico. One of the few non-tropical sources of rubber. The rubber is present not in the latex but as small granules in the tissues. The % age of rubber and resins varies considerably in different parts of the plant (leaves, stems, roots, bark, etc.)
Taraxacum kok-saghyz (COMPOSTAE) ..	84·5	11·2	3·1	1·2	*Dandelion rubber.*—A native of Kazakstan in Central Asia. It grows in Russia and the rubber is extracted from its roots. Another non-tropical source of rubber.

On comparison of the results in Tables I and II one thing is outstandingly clear, namely, that in all good-quality rubber the proportion of resin is exceedingly low and that of caoutchouc very high. For example, in para rubber the proportion of resin to caoutchouc is as 1 : 35 and in ceara 1 : 7.5.

With the exception of *Cryptostegia grandiflora,* in none of the latex, so far examined, has the proportion of resin and caoutchouc been of the order shown above. In fact, the position is reversed. The proportion of resin is unduly high and that of caoutchouc low. For these reasons it is probable that caoutchouc from none of these could be used directly for manufacturing purposes although trials are at present being made.

Cryptostegia grandiflora is one of the hopeful species but this, too, has its own peculiar difficulties and problems especially those connected with tapping the latex from a shrubby climber such as this. The problem and work connected with the cultivation and exploitation of this plant have been allotted to the Imperial Agricultural Research Institute, New Delhi, as it is a non-woody species.

A scrutiny of the results tabulated in I will reveal that the problem apparently does not seem to hold out great hopes on account of the low percentage of caoutchouc in most of the species. The only species which may be worth considering are the ones possessing rubber content of more than five per cent. in original latex, marked * in the table. Some of them are not as common as would permit their economic exploitation and have consequently to be dropped. As a result of further scrutiny, the number of hopeful species is reduced to 7 of which two are of the gutta-percha type—*Pallaquium* (*Diochopsis*) *ellipticum* and *Madhuca* (*Bassia*) *latifolia.* The rest are of rubber type: (*a*) *Wrightia tinctoria* (*b*) *Wrightia tomentosa,* (*c*) *Tabernaemontana heyneana,* (*d*) *Ficus glomerata* and (*e*) *Poinsettia pulcherrima.*

As has been stated before, the high resin content of these species offers the main difficulty. The usual solvent methods of deresination cannot be looked upon as a solution of the problem for obvious reasons of their cost and availability. Therefore mechanical, physico-chemical or biological processes, resulting in the disintegration of resin from rubber, will have to be evolved. The investigations are already in hand and it is hoped that even if a partial deresination is achieved by simple means, it will go a long way to find commercial utility for their coagulum. Variations due to season, age, climate, soil, etc., are other interesting factors which are being looked into.

It may be stated that the results are in the nature of an interim report and are often based on single analyses which have to be confirmed by repetitions.

A NOTE ON CYCLONIC STORMS

By E. L. P. Foster,

Lately Chief Forest Officer, The Andamans.

"Dear God! My boat is very small—and Thy sea so very wide. Have mercy!"
—*Breton Fisherman's Prayer.*

The author does not claim any expert knowledge, and these notes have been chiefly extracted from John Eliot's "Handbook of cyclonic storms in the Bay of Bengal." The book has long been out of print but it remains one of the finest books on the subject. Operating small craft in the Andaman Sea for nearly seven years makes one take an acute interest in the weather.

Air behaves like water in that it runs from an area of high pressure to an area of low pressure. When ascending air causes an area of low pressure, the air from outside must come in to fill the vacant space. If the pressure is very low, the air comes in at a considerable velocity and high winds result. These winds enter the inner portion of the storm in a curve, caused by the rotation of the earth. This causes the storm to gyrate. In the Northern hemisphere the storm revolves in an anti-clockwise direction: the opposite is the case in the Southern hemisphere.

It has been estimated that, to move the air which comes under the influence of a big cyclonic storm, energy equal to the power developed by half a million 6,000 ton ships is required. This energy is partly derived from the sun causing movement of the air, and also from the very heavy rain which persists in the centre of a cyclonic storm: evaporation of water requires energy and this energy is released when the vapour condenses in the form of rain.

Air may move in the form of wind without causing a cyclonic storm. Both North-East and South-East Trades and the South-West monsoon work like a driving belt on a couple of pullleys. The air travels along the surface of the earth for a distance, then rises and flows back in the opposite direction at high altitudes. The usual velocity of the South-West monsoon in the Andaman Sea is 18 to 28 miles per hour.

All storms in the Bay of Bengal are cyclonic in character. A true cyclonic storm is composed of three zones. An outer zone, where the barometer falls slowly and winds of 22—25 m.p.h. are attained. An inner zone where the barometer falls very rapidly and the winds reach hurricane force (over 65 m.p.h.). There is a "calm zone" but this is not always present. In this area there is little wind or cloud, the sun or stars may be visible, the sea is "pyramidal and boiling like a cauldron." This calm centre is presumed to occur only in great storms and may be 15 to 20 miles in diameter.

A rough and ready method of finding the direction of the centre of a cyclonic storm is to bring the right arm level with the shoulder and to force it backwards

as far as it will go, point it in the direction from which the wind is coming: if the left arm is forced into a similar position, it will be pointing in the direction of the centre of the storm. In other words the angle formed by the direction of the wind, the observer and the storm centre is 112 to 135 degrees (10—12 points).

The shifting of the wind will enable one to follow the movements of the storm centre. If the wind does not shift, you are "for it" properly. For instance, if the wind is East-North-East and remains fixed in that quarter, it means that there is a cyclonic storm to the South or South-by-West of you and it is coming straight for you. Cyclonic storms in the North-East monsoon are most unpleasant, because they can approach from the South without causing an appreciable shift of wind. As an example of the way in which shifts of wind make it possible to follow the course of a storm, if a storm proceeding in a Northerly direction is passing to the West of one, the wind will shift through East to East-South-East, to South-East, to South-South-East, etc., at which stage one will be safe from the storm and the weather should improve rapidly, unless a "secondary" is following the cyclonic storm.

Unfortunately the barometer, which is such an excellent weather guide in the Western Ocean, is not nearly as useful in the Bay of Bengal. It is exceedingly insensitive. A fall of only .1" to .15" in 24 hours indicates a cyclonic storm in the vicinity. In five years' observations, nine such falls resulted in six officially-recognised cyclones. A rise of .1" to .15" in 24 hours similarly denotes the presence of a cyclonic storm. In five years, 11 such rises resulted in eight recognised cyclones. I am personally of opinion that the rise is a more common indication than a fall; anyway it is an earlier symptom.

The other indications are:

1. The presence of "Mare's tails" (cirrus clouds) in the sky. This is often a far, far earlier sign of bad weather than is given by any barometer in the Bay.

2. Squalls become gradually more frequent and fierce as a cyclonic storm approaches. At first these may be quite light and separated by intervals of fine weather with light variable winds. This period may extend over a few days or hours. Squally weather is an invariable antecedent of a cyclone, but it does not follow that a cyclone invariably follows squally weather. Fortyeight hours before a violent cyclone the weather has been described as "squally" and the sea "Very tranquil but sun blood-red on the horizon when setting. Clouds of different sizes detached one from the other passing with great velocity."

3. Large banks of black cloud may be observed, frequently much pierced by lightning, while the observer is in comparatively fine weather.

4. Descriptions of the blood-red and other peculiar colouration of the sky is repeatedly mentioned in accounts. The cause of this is the high moisture content of the atmosphere which splits up the colours of the spectrum and absorbs the violet and blue rays.

5. A cyclonic storm throws off a swell, rather as mud is thrown from a car wheel. This swell travels faster than the storm and may be felt 400-600 miles away from the storm centre. For ships at sea, therefore, this may be a very early intimation of coming trouble.

6. A distant cyclonic storm may be heralded by usually fine, bright and clear weather.

A cyclonic storm may travel at only 2 m.p.h. in its early stages, 8-12 m.p.h. is the usual speed. In the North of the Bay it may travel at as much as 25 m.p.h.

Cyclonic storms do not occur in the Northern hemisphere to the South of 8° North. Almost all originate in the Bay but, in rare circumstances, they may start in the Gulf of Siam. The Port Blair cyclone did this on November 1st to 7th, 1891. *The Andaman Sea is always credited with being the favourite breeding ground of* cyclones. Fortunately, these usually travel between North and West, but one crossed the North Andamans proceeding in a North-East direction.

Different areas of the Bay are dangerous at different times of the year. For instance, in April cyclones are mostly rather to the South of the Bay, but may occasionally be as far North as the Andamans. In early May they mostly originate in the Andaman Sea. By July and August, they have usually worked up to the extreme North of the Bay. By October the cyclones are back again in the Andaman Sea and this is the most dangerous month of the year in the Bay of Bengal. By December the cyclones are operating far down in the South of the Bay.

The course taken by cyclonic storms usually lies between West and North-North-East, in fact very seldom East of North. Special circumstances may cause an abnormal path. The course of one cyclone in the Arabian Sea is depicted as being the shape of an "S" lying on its side.

The book, from which most of this information was obtained, was written long before aircraft were invented or, at any rate, became common. Much of the data may now be proved to be wrong, but it is difficult to find a seaman in the Bay who will agree that a better book has been written.

IMPROVED WOOD

By D. Narayanamurti

From times immemorial, wood has been a most important material for construction and fabrication. Its easy availability, low cost, ease of working, good strength properties, low thermal conductivity, high specific heat, high electrical resistance and other favourable properties have made it an excellent material for many purposes. Weight for weight, wood is found to be better than steel and other materials, as is illustrated by the following table:

Material	Density gm./cm.^{3}	Compressive strength / 100 × density	Tensile strength / 100 × density	Bending strength / 100 × density
Spruce	0·48	9·9	24·7	21·2
Scots pine	0·65	11·5	26·2	17·2
Ash	0·65	9·2	20·1	19·0
Walnut	0·60	11·3	21·0	23·3
C-steel of 36 Kg/mm^2 tensile strength ..	7·85	2·3	4·6	..
Duralumin	2·9	..	14·0	..

In these modern days wood has to compete, not only with simple metals, but with special alloys, synthetic resins and plastics. The properties of metals have been improved by careful purification and alloying with other metals, so that materials of greatly improved properties have been made available for industry. Wood has, up till recently, been used mostly in the natural state with the attendant defects, such as "working" with changing atmospheric conditions, and its non-homogeneity and other factors. So, recent research has been directed to improving wood in these and other respects, so that it can hold its own against other powerful competitors.

Various methods and processes have been devised during recent years for the production of wood with improved properties and it is now possible to produce a valuable product from wood which was originally fit only for firewood. During the past years experiments have been carried out at the Forest Research Institute on the production of "improved wood" and the results of these experiments are briefly described in this note.

Compressed Wood.—As is well known, the strength properties of wood improve with specific gravity. By compressing wood across its fibre direction, and thereby increasing its specific gravity, attempts have been made to improve the strength properties of wood. Theoretically it is possible to compress wood to a density of 1.46 gm/cm^3 so that no air space is left in it. Experiments carried out in Europe on

poplar showed that, with comparatively low pressures, small compression can be obtained but, when the wood was compressed to less than 0.4 of the original thickness, the pressure necessary for further compression increases rapidly. Moisture content up to 25 per cent. was found to have no influence on the pressure necessary for compression. On removal from the press the wood recovered to a certain extent but, even after considerable lapse of time, it did not recover its original dimensions. The extent of recovery was dependent on the moisture content at the time of pressing. It was independent of the compression in the range of compression 0.2 to 0.6. But the final recovery was found to be the least when the moisture content was about 16 per cent. to 18 per cent. at the time of pressing.

Some experiments were carried out at Dehra Dun with *Moringa pterygosperma*, kiln-dried to a moisture content of 12 per cent. to 14 per cent. Preliminary trials to compress the wood at ordinary temperature having proved unsatisfactory, compression of the wood at about 300 to 320 degrees Fahrenheit, under a pressure of 500 to 2,000 lbs./sq. in., was resorted to with interesting results. The variation of the compressive strength with specific gravity of the compressed wood is illustrated by Fig. 1 below. On soaking in water, the compressed wood, even though it took up

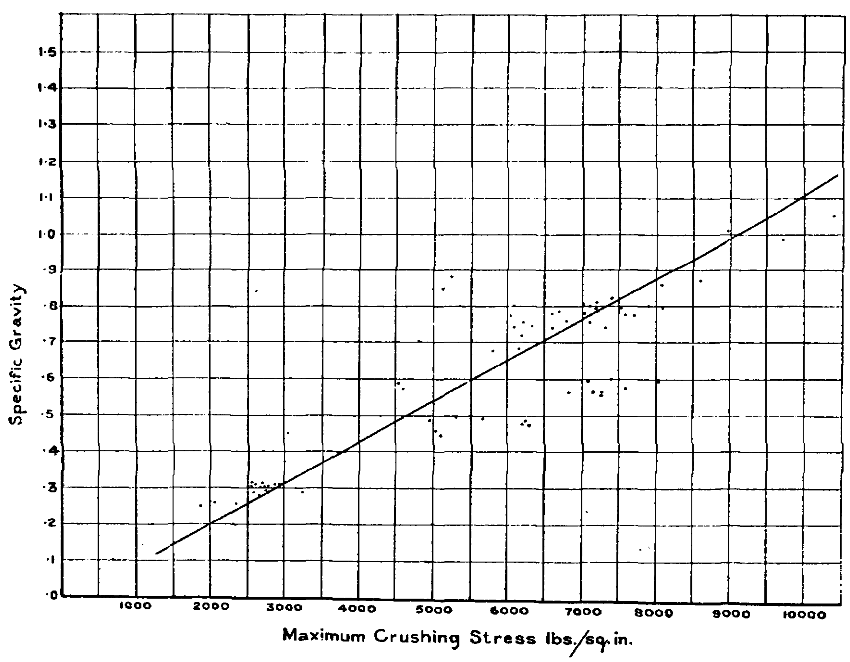


Fig 1.

moisture and swelled considerably did not recover its original dimensions. The possible applications of such material are as bearing plates on sleepers (it is understood that wood of this description is being so used in Europe) and similar uses.

Lignostone, produced by compression of wood scantlings (mainly beech) on all sides, by a patented process in Europe, has been found to possess very favourable properties and finds application in the manufacture of shuttles and other textile mill auxiliaries, etc.

Improvement of the Properties of Wood by Impregnation with Synthetic Resins.—Various attempts have been made to improve the properties of wood by impregnation with various substances, *viz.*, oils, waxes (like Montan wax), natural resins and synthetic resins. It is interesting to record that such treatments with oils and natural resins are mentioned in Bethel's patent taken out in 1838.

Impregnation with synthetic resins like bakelite has been found to improve the strength properties of wood, especially the compressive strength perpendicular to the fibre direction. The resistance to moisture absorption is also considerably increased. However, even with specimens simple in shape and small in dimensions very poor penetration of the resin was obtained in experiments carried out in Europe. Further, the specimens became deformed and those with bigger cross-sections had cracked due to the solidification of the resin, with attendant stresses. In addition, bakelised wood was found to be more brittle than untreated wood.

In tests carried out at Dehra Dun, timber specimens treated with various types of resins by the diffusion, Boucherie or pressure processes were conditioned to a moisture content of 10 per cent. to 15 per cent. and were then cured at 60 to 100 degrees C at an air pressure of 30 lbs./sq. in. the temperature being gradually raised to the maximum. In Table I some of the results obtained are given (*vide Appendices*).

As can be seen from the results, it is possible to improve the strength properties of inferior types of wood by impregnation with synthetic resins and other materials. In these experiments, the moisture absorption of the treated specimens was also found to have been considerably reduced. The variable results obtained were due in the main, to the quality of the timber used in the tests and to the difficulties of the processes tried. With greater care it is probable that better results than those reported could be obtained. But, as impregnation processes are not easily applicable to large sizes of timber and with all species of timber and all types of resins and as better results can be obtained by using laminated treated veneers, further work on the impregnation of Indian woods with resins was discontinued for the present.

Laminated Wood.—Growth defects like knots are localised and often form the weakest part of a wooden structure when solid wood is used. Such failures can be reduced by dividing wood into thin lamellæ which are again glued together in such a manner that the localised defects are distributed. This can best be illustrated by the examples shown in Fig. 2 below, where through the presence of a knot the cross-

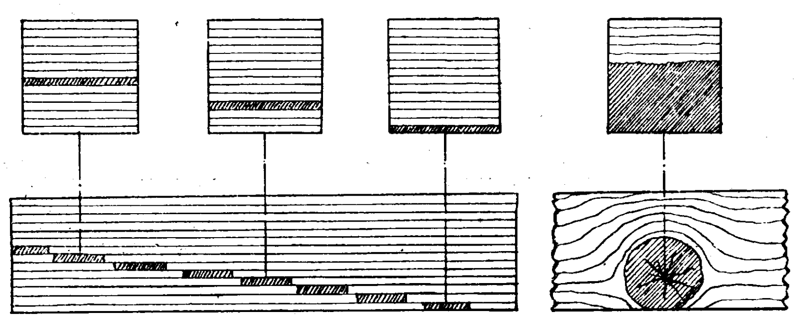
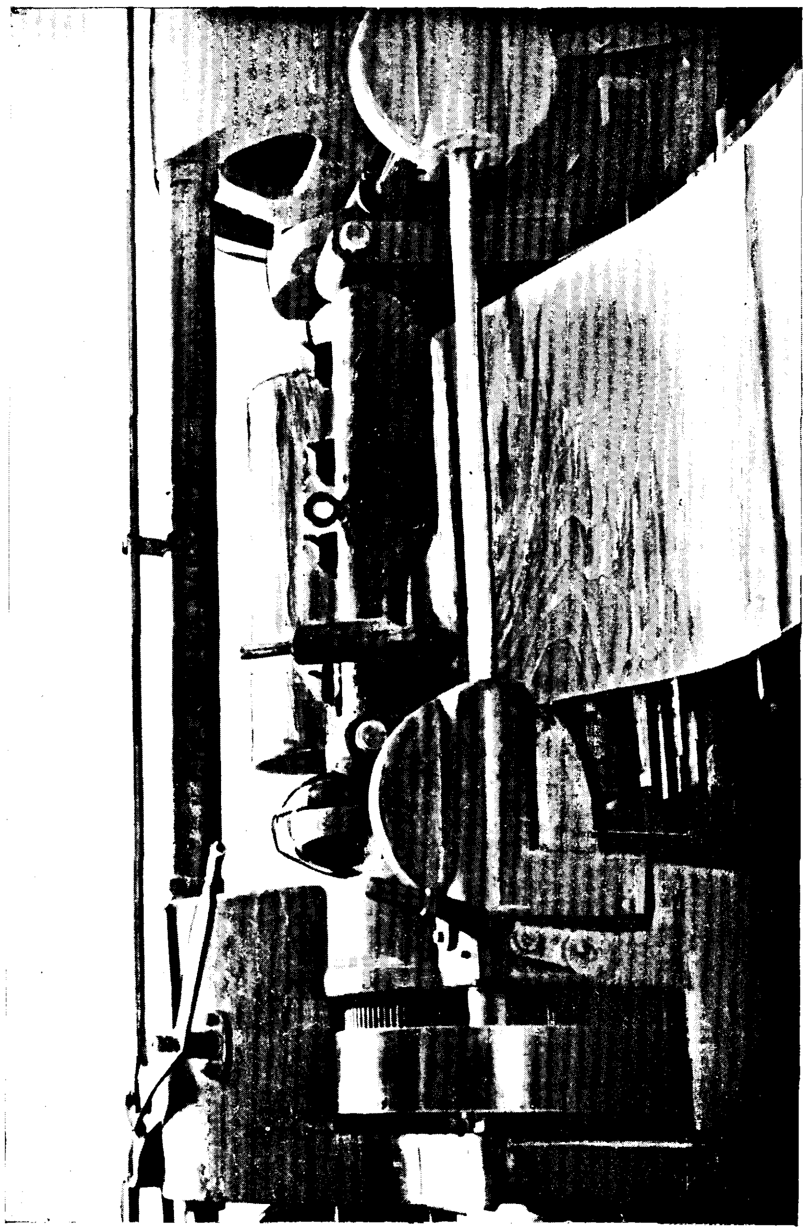
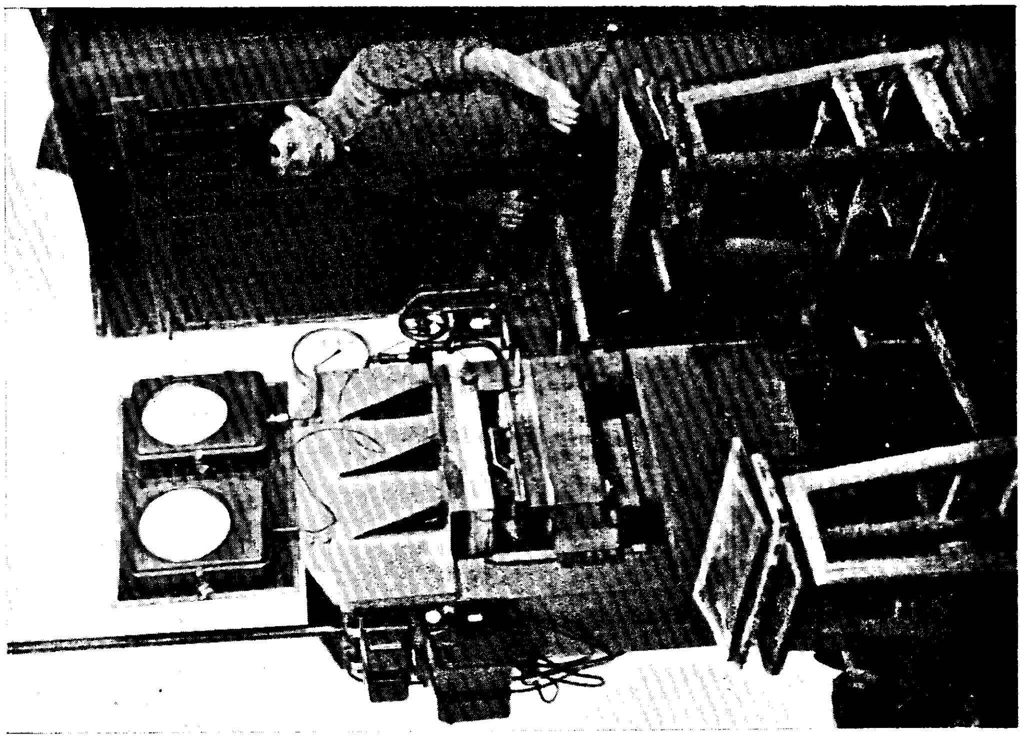


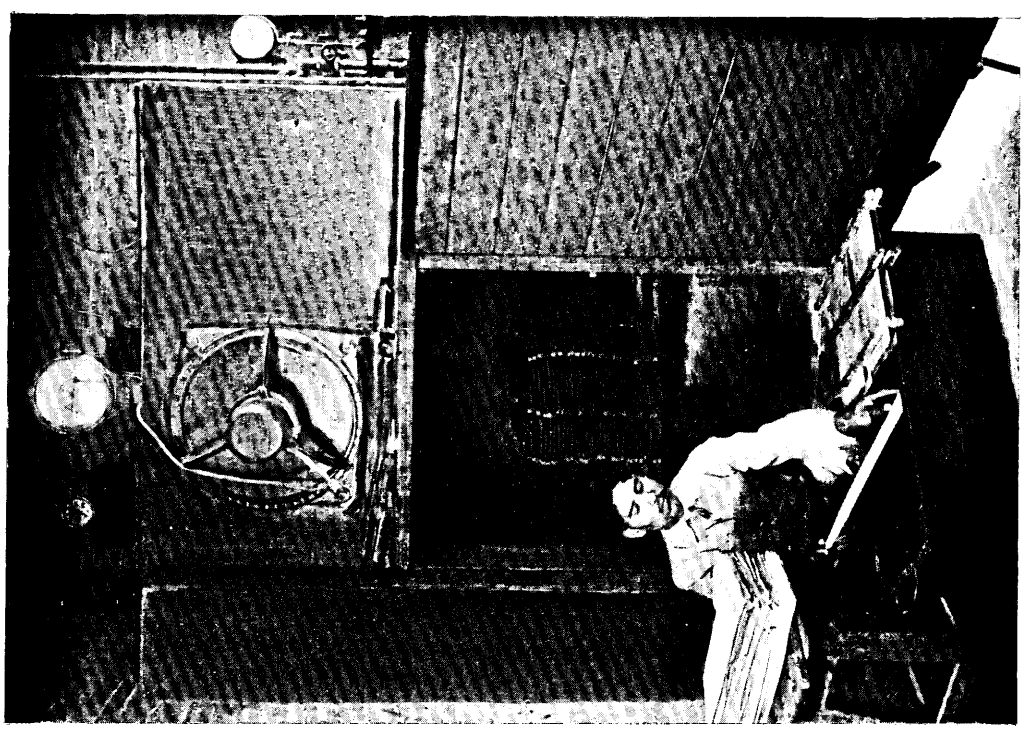
Fig. 2



Peeling veneer on the rotary peeling lathe. Forest Research Institute, Dehra Dun



Presssing the treated veneers into a board. Forest Research Institute, Dehra Dun.



Dipping the veneers before pressing. Forest Reseach Institute, Dehra Dun.

section of a member is considerably reduced. By cutting the piece into several lamellæ and rearranging the strength is reduced to only a small extent. One of the main difficulties in adopting this type of construction in India was the lack of water and moisture-resistant adhesives. With the advent of synthetic resin adhesives this difficulty has been overcome.

Laminated boards of *Bombax malabaricum,* made by dipping the veneers (varying in thickness from 1/8″ to 1/72″) in 40 per cent. tar-acid formaldehyde resin solution. conditioning at a low temperature and pressing together at about 300 degrees Fahrenheit in a hot press at a pressure of 160 lbs./sq. in. when subjected to mechanical tests were found to have improved in all properties (*Plates 15* & *16*). The increase in compressive strength was especially favourable, the strength increase amounting to several hundred per cent. Laminated semul, on unit-density basis, was found to be even better than average teak. Shear was another property which had considerably improved. Hardness was nearly doubled and the bending strength considerably increased. In Figs. 3 and 4 below the various strength properties as a

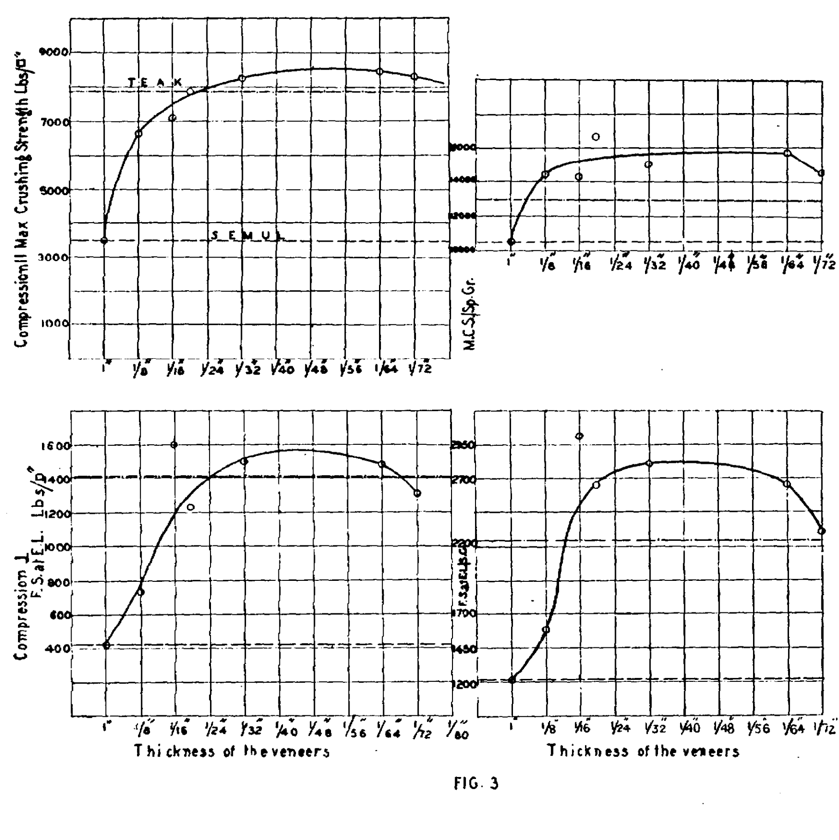


FIG. 3

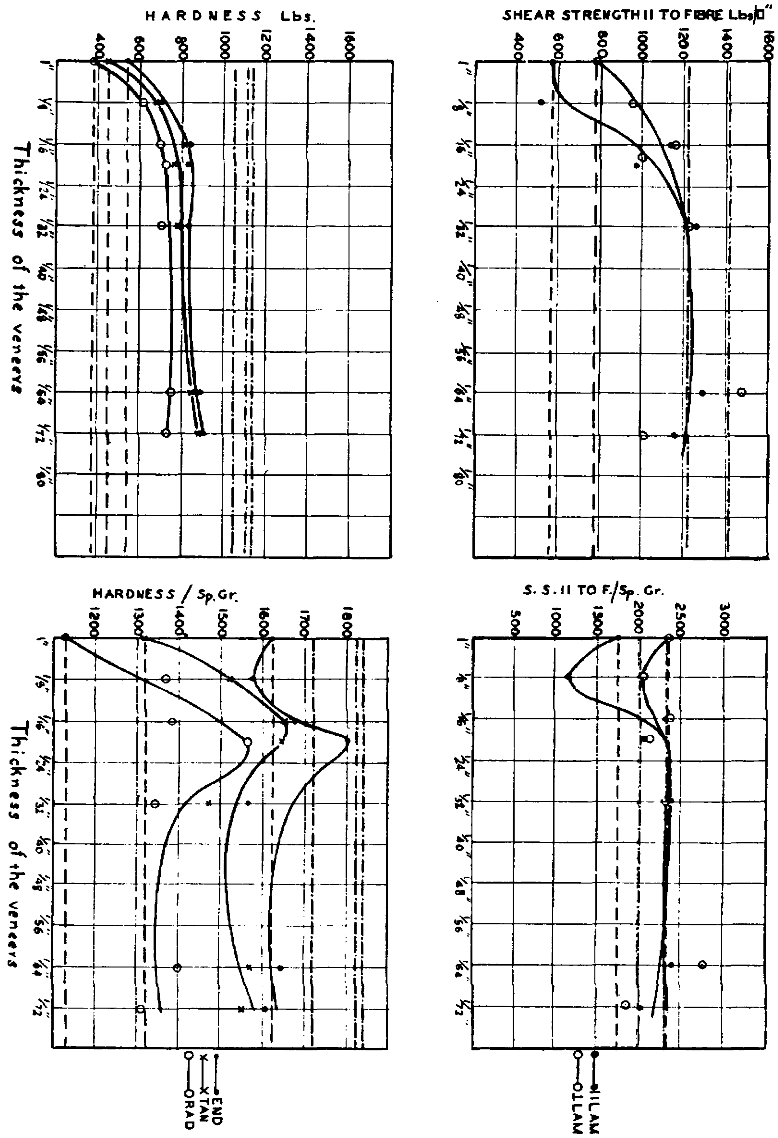


Fig. 4

function of the number of layers of veneer per inch thickness are given. The strength figures for *semul* and teak are also given as broken lines for comparison.

Lamination at Various Angles.—Wood being an anisotropic material its strength properties in different directions are different. The modulus of elasticity across the grain is only a fraction (about 2.5 per cent.) of that along the grain. For many technical uses (aircraft structures, etc.), this non-uniformity is a great disadvantage. Plywood construction tends to reduce this defect. By increasing the number of laminations and by suitable choice of veneer thickness and direction of laying, laminated wood, having very uniform properties in all directions, can be produced.

The results obtained with laminated boards of *Michelia champaca,* using tar acid-formaldehyde resin as the adhesive are illustrated by Fig. 5. With solid wood

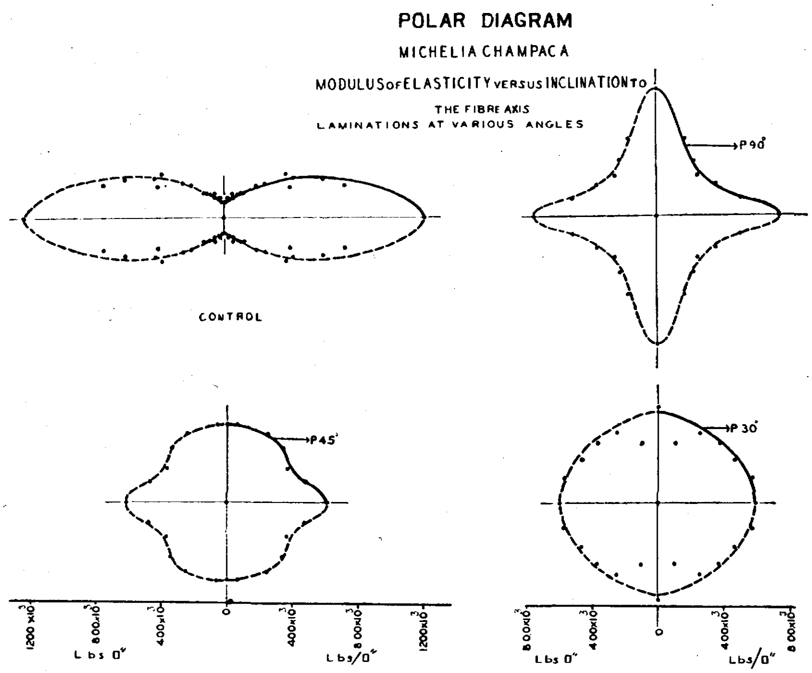


Fig. 5

and simple lamination the strength shows a rapid decrease from along the grain to across the grain. With the normal plywood type of construction there is more uniformity in the properties. With this type of construction the strength properties along the grain and across the grain will not vary considerably as in both directions the low strength of the cross plies is compensated for by the other plies. When, with such a plywood, the force is applied at an angle less than 45 degrees to the fibre axis of the outer plies, the strength is mainly decided by the outer layers and those inner layers which are parallel to the outer ones. The reverse is the case when the direction of the applied force is greater than 45 degrees to the fibre axis of the outer plies. The application of the force at an angle of 45 degrees to the fibre direction of the outer layers is a special case, as the force then acts on all the plies at this angle and hence the strength value obtained will be minimum. This is clearly seen from the results represented as a polar diagram in Fig. 5. It will also be clear that by increasing the number of layers and arranging them at an angle of 45 or 30 degrees to one another greater uniformity can be obtained. In the ideal, the diagram should be a circle. It will be seen from the figures that the 90-degree construction is better than pure lamination and 45-degree construction is better than the 90-degree one. The best results are obtained with 30-degree construction. The ratio of the area of the figure to that of a circle having as radius the strength along the grain of the veneer can be taken as a measure of the quality of the product.

Laminated material of this type is useful for aircraft parts (spars, propellers, etc.), textile mill auxiliaries, sports goods, gunstocks, etc. In consequence of its high bearing strength under bolts and shearing strength, by the use of this type of improved wood, it is claimed that spars constructed of this material weigh only about a third of ordinary wooden spars.

Compregnated Wood.—Wood of highly improved properties can be obtained by a suitable combination of the three processes described above, *viz.*, impregnation, lamination and compression. In the case of "compregnated wood," by sub-division of wood into veneers and impregnation, or by placing thin films of resin between the veneers, the pack is compressed at a high pressure and suitable temperature. Alcoholic solutions of the resin, or film glues like Tego-film, etc., are used. By suitable choice of the wood, thickness of the veneer, the pressure, temperature and direction of laying the veneers, the properties of the resulting material can be varied and made to suit particular requirements.

Experimental work on compregnated wood using Indian timbers done in the Wood Preservation Section has yielded interesting results. The strength of some samples of compregnated wood made at the Institute along with the results of foreign observers are assembled in Table II (*vide Appendices*). It will be seen from the results reported that it is possible to produce compregnated wood of suitable properties in this country. By suitable combination of different species of wood very interesting results were obtained.

In addition to favourable strength properties compregnated wood was found to have good electrical, thermal, moisture and fire-retardant properties.

The uses of compregnated wood are very varied and many. It is an ideal material for aircraft-propeller blades. The main defects of natural wood for aircraft-propeller blades are low hardness, low cleavage strength, low shear strength and hygroscopicity. With the advent of compregnated wood these defects no longer exist and the advantages of using compregnated wood for the construction of aircraft-propeller blades are, high tensile and shear strength which can cope with the high centrifugal stress at the boss which, at the same time, are reduced to a minimum due to the low density of the material in contrast to metal, high damping capacity, favourable strength/density ratio, lightness (weight of such blades is a third of metal ones), and increase in efficiency (about 60 per cent.). Another use of the material is for gear wheels. The advantages of compregnated wood are in contrast to iron, silent running, lesser weight and lower power consumption; in contrast to raw hide, cheapness (metal side discs are not necessary) and longer life. The material is also very useful for bearings (ship-tail shafts, rolling mills, etc.), press forms, gunstocks, textile mill auxiliaries, the electrical industry, etc.

TABLE 1.

Species of Timber.	Type of resin.	Process.	Absorption of resin percentage.	Moisture content percentage.	Specific gravity.	Max. crushing strength lb/sq. in.	Increase.		Strength.	Increase percentage.
							Sp. Gr. percentage.	Strength percentage.	Specific Gravity.	
Erythrina suberosa	Phenol-formaldehyde resin.	Diffusion ..	*0	12·5	0·297	2468	..	..	8320	..
,, ..	,, ..	,, ..	103	9·7	0·584	3981	96·6	61·4	6820	—18·0
Moringa ..	,, ..	Pressure ..	*0	11·4	0·292	2048	..	..	7026	..
,, ..	,, ..	,, ..	..	11·8	0·625	2645	115	29·2	4240	—38·6
,, ..	,, ..	Open Tank ..	*0	12·2†	0·280	2321	..	..	8290	..
,, ..	,, ..	,, ..	85	3·9	0·553	4875	97·6	110	8820	6.4
,, ..	,, ..	,, ..	*0	12·7	0·298	2525	..	..	8480	..
,, ..	,, ..	,, ..	84	3·7	0·568	6350	90·6	152	11180	31·1
,, ..	,, ..	,, ..	120	3·8	0·659	6970	121	176	10600	25·0
Kadam ..	,, ..	Boucherie ..	*0	18·7	0·302	4112	..	..	13600	..
,, ..	,, ..	,, ..	..	8·6	0·499	6246	65·2	51·8	12500	—8·1
Moringa ..	,, ..	,, ..	*0	18·7	0·190	1031	..	..	5430	..
,, ..	,, ..	,, ..	..	16·6	0·347	4463	82·7	333	12900	137
,, ..	Cresol-formaldehyde.	Pressure ..	*0	11·5	0·305	2258	..	..	7400	..
,, ..	,, ..	,, ..	82	12·9	0·556	7349	82·3	225	13200	78·4

*0 absorptions refer to control specimens.
†The lower hygroscopicity of the resin-treated specimens can be seen from these results.

TABLE II

COMPARATIVE STATEMENT SHOWING THE STRENGTH FIGURES FOR COMPREGNATED WOOD MADE AT THE FOREST RESEARCH INSTITUTE FROM INDIAN TIMBERS WITH FOREIGN SAMPLES.

Species or Type.	Specific gravity.	Tensile strength lbs./sq. in.	Modulus of rupture lbs./sq. in.	End. Comp. lbs./sq. in.	SHEAR* PARALLEL. lbs./sq. in.	SHEAR* PERPEN. lbs./sq. in.	HARDNESS PERPENDICULAR lbs.	HARDNESS PARALLEL lbs.	HARDNESS END lbs.	BRITTLENESS. ft./lbs.
Birch, root of screw ..	1·27	..	3,1200	17,700	5,000	2,840	5,790	5,850	4,170	12·5
Birch, whole comp., root ..	1·17	..	26,200	14,550	3,000	4,620	5,010	5,850	..	8
†Jablo ..	1·30	31,295	31,295	19,915	5,690	8,885	..	..	..	..
Jablo ..	1·36	39,830	..	24,893	5,975	..	..	..	..	..
†Weybridge ..	1·40	33,000	..	..	4,000	15,000‡	..	..	..	..
†Jicwood ..	1·37	47,600	..	26,400	7,400	..	..	..	..	..
†Birch ..	1·30	31,300	..	21,300	7,000	5,700	..	..	..	..
†German ..	..	29,000—43,000	36,000—40,000	14,000—17,000	3,000—6,000	14,000‡	..	..	..	..
						..	..	..	..	..
Semul ..	1·19—1·31	24,000	..	22,000	..	2,000	3,700	..	..	9
Toon ..	1·24—1·31	36,000	35,300	21,000	3,800	5,200	6,300	..	5,200	11·5
Hollock ..	1·25—1·30	42,000	37,700	20,000	2,500	4,000	4,500	..	4,600	9·8
Zanthoxylum Rhetsa ..	1·13	..	33,300	16,300	1,775	2,237	4,140	4,458	3,885	19
Mulberry ..	1·25	..	28,400	16,700	3,237	3,930	6,490	6,075	5,770	10
Salai ..	1·21	..	23,200	16,900	2,435	4,149	3,245	3,675	1,550	5
Spruce ..	1·18	29,000	25,200	14,000	1,600	4,000	3,600	..	3,100	14·5

*Parallel or perpendicular to laminations. †Taken from the literature. ‡Across the grain.

ENTOMOLOGICAL NOTES

By J. C. M. Gardner
(*Forest Entomologist*)

1. *Introductory.*—The Editor has asked me for an article for the present issue. Instead of writing on a single subject I propose to start a series of disconnected notes of which some, at least, may be of general interest. It is hoped that readers of the *Indian Forester* will themselves contribute notes, comments and suggestions.

2. *Importance of Honey-bees.*—A recent article in *Nature* reminds us that honey is only a by-product in the United Kingdom from the national point of view, for it is estimated that whereas the annual value of honey produced is one-and-a-quarter million pounds; the value of the honey-bee as a pollinator of such crops as fruit, clover and mustard is four million pounds. The bee is the most important pollinating insect of these crops and at times, as in the cold spring weather in England, is almost the only one on the wing. Recent work in the U.S.A. has shown how important it is for fruit and seed growers to understand bee habits; bees have preferences for certain flowers; for example, in the Pacific North-west, they prefer a mustard crop to neighbouring fruit trees and, to favour the latter, competition should be eliminated by removing the mustard crop or arranging a crop that blooms after the fruit has been pollinated. In the U.S.A. a serious problem is introduced by the necessity of spraying crops against insect attacks, the chief danger being arsenic, .00005 grams of which will kill a bee; it has been shewn that certain agents such as nicotine and lime-sulphur repel bees and it may be possible to use them to prevent bees poisoning themselves.

Fletcher has already pointed out that it would be well worth-while keeping the Indian Bee (*Apis dorsata*), a poor honey-producer, in orchards for pollination alone. We have a great deal to learn about the insects associated with the insect-pollinated trees of India and records by forest officers would be interesting.

3. *Boswelia serrata Borers.*—This tree has assumed considerable importance for box-wood as a result of war demands. The felled log has the property of maintaining the bark in a green and healthy condition for some months. With the bark in this condition there is little liability to insect attack but when decay sets in, a beetle of peculiar appearance, *Atractocerus reversus,* lays eggs and the wood becomes seriously bored by resulting larvæ. An apparently reasonable prescription would be to keep the felled logs in shade to keep the bark alive. However, this is not always practicable since shade is rarely available in *salai* areas. The alternative is to remove the bark when, although other insects will attack the wood, only slight superficial damage will result, judging from observations made so far. A serious objection to this may be the deterioration of barked logs by cracking, but further observations on this point are necessary.

4. *White Ants.*—Enquiries on the control of termites, especially when attacking buildings, are always numerous. Unfortunately, it is the fashion to erect buildings before considering termite risk with the result that expensive remediable methods are required. Anti-termite prescriptions should be part of the design for a

new building. Beeson's collection of information on termite control (*Indian Forest Records, Vol. IV, No. 2, 1941*) was soon out of print and has now been reprinted.

About one hundred species of termites have been recorded from India; or more accurately a hundred specific names have been established, for there is great confusion in literature and many of the alleged species cannot definitely be recognized from descriptions. The whole subject requires full-time research. Many species are of little economic importance and some are beneficial.

5. *Beneficial Parasites.*—The idea of maintaining other plants which support parasites attacking pests of the main crop seems to have first been advocated by Silvestri for controlling the olive fly. It was also used with success in the United States in the fight against the cotton boll-weevil; it was found that certain weeds bordering the cotton fields supported beneficial parasites and that if the weeds are cut at a certain time the parasites would be compelled to transfer their attentions to the main pest. The plan of maintaining certain plants as undergrowth for this purpose has been advocated by Beeson for the control of teak defoliators and has been under further investigation.

The effect of burning in Indian forests requires further study; it may prove seriously to interfere with parasites. Burning has been recommended as a control measure for certain agricultural pests: for example, for control of a wheat midge by burning the debris after threshing, but it was subsequently shown that the debris contained the parasitized larvæ while the healthy pest larvæ entered the ground and, therefore, survived. In another carefully analyzed instance, in the United States, it was found that attack by the sugarcane borer was considerably more severe in areas where the trash was burned than where it was not.

SUGGESTIONS FOR THE PROTECTION OF RAILWAY BRIDGES IN ASSAM

By D. C. KAITH, B.SC. (EDIN.),

Chief Forest Officer, Bijui, Assam

The writer is not aware whether the suggestions which follow have been examined by river-training engineers or those interested in the subject. But still he ventures to offer them as they have appealed to him in the course of experience he has had to receive during his tours in the district.

The importance of the Bengal and Assam Railway section between Golakganj and Amingaon railway stations cannot be exaggerated in wartime. It is a well-known fact that with even slightly unusually heavy rainfall in this sub-Himalayan tract rail communications are dislocated. Before giving temporary remedial measures for the protection of bridges, a short description of the country north of the railway line appears essential.

The tract in question is called "the Duars," occupying a stretch of country about 150 miles long between rivers Sankosh, Manas, Beki and beyond with a width of 30-40 miles from the base of the Bhutan hills southwards into the plains. To the west of the Sankosh river which forms the boundary between Bengal and Assam, there are the Jalpaiguri and Buxa forests of Bengal known as "the Western Duars"

and to the east are the Goalpara and Kamrup forests called "Bijui" and "Sidli Duars", which are covered by *sal* and other tree species and miles of tall grass jungle. The Duars are drained by numerous rivers which cross the railway at right angles and join the Brahamaputra. The formation of the country is divided into Bhabar and Tarai.

The Bhabar is a stretch of deep waterless boulder deposit at the foot of the hills. It commences from east of the Ganges in the United Provinces and stretches to the Assam Duars with breaks here and there. The Bhabar deposit is porous and all but the large rivers like the Sankosh, Champamati, Aie, Manas and Beki sink into the ground on coming out of the hills, their beds remaining dry except in the flood season, the natural water flows at great depth under the surface until it reaches the Tarai tract which is marked by swamps, quicksands, streams full of water and the railway runs through it. Most of the Bhabar tract consists of the reserved forests of Goalpara and Kamrup districts of Assam. Outside the reserves, there are contiguous unclassed State forests which are being opened for cultivation. In the reserved forests between the Champamati and Beki rivers there is savannah grass occupying miles of the country with deciduous trees, specially *Acacia catechu* and *Dalbergia sissoo,* along the sandy banks of rivers. Many of the rivers are dry in the cold weather but become turbulent in the rains. The alluvial *sissoo* and *khair* forests are a characteristic feature of the rivers and grow gregariously in the beds of rivers on the new alluvial lands thrown up in the shape of islands and low banks formed of deposits of sand, shingles and boulders. Rivers change their course very often and erode the banks, uproot and sweep away many trees, dead and alive, which form enormous quantities of drift wood which floats down the rivers in flood and gets stuck against railway bridges and smashes them.

The tract between the reserved forests and the railway, once thick jungle when the railway was built, has since been gradually opened up for cultivation by settlers from Bengal. Sandy banks, once covered and stabilized by grass, are now denuded of vegetable cover and are breaking up. For irrigation purposes people have tapped the rivers by building water channels locally called *dongs*. This practice *of* cutting *dongs* cross-country is very seldom regulated by any Government agency. The Forest Department tries to enforce its will but is powerless before popular clamour for more *dongs*. These *dongs* in alluvial plains are turning into new rivers. The Champamati river has changed its course into the Tarang *Dong* which has now become a big river and necessitated the building of wider and new bridges.

Some of the adjoining tracts of the Aie river have been overgrazed and high sandy banks are breaking up inside and outside the reserved forests. Some depressions along the banks of rivers caused by undercurrents and earthquakes are being eroded too.

Fires cause great damage to savannahs between the Aie and Manas rivers. Every year miles of grass jungle is burnt and the ground becomes naked and is without the sponge cover of humus which could retain water. The forest cover having disappeared, rain-water flows quickly into the streams and sudden rises cause damage to railway bridges.

The annual rainfall of Goalpara is 109 inches and that of Kamrup 81 inches; but it is heavier towards the Bhutan hills and many a time when there is more rain

in Bhutan, a sudden rise of the rivers is noticed. Means of getting rainfall reports from Bhutan are nil and the Assam forest department also does not keep records of rainfall along foothills.

From the above factors it can be deduced that though the width of bridges has remained the same, the flow of water, the quantities of sand and gravel, the drift wood carried by rivers through the bridges, has increased tremendously since the railway was built. Banks of rivers have become unstable due to the opening up of the adjoining country. To widen the bridges in war-time is not a practical proposition but the following simple remedies are suggested to minimise the damage and keep the vital communications of Assam intact by controlling the flow of water and adopting anti-erosion measures:

(1) *River Training*.—Along all streams and rivers two to three miles above the bridges, banks should be stabilised and rivers trained to flow in permanent channels by timber and bamboo palisades. Naked sandbanks should be covered with turf. Cultivation should be controlled along river banks for a few miles above the line.

(2) All along the rivers, a labour force should be posted to collect drift wood and chop down and remove trees which are likely to be eroded away and cause jams in front of the bridges in times of flood.

(3) Batches of boatmen should be posted above the bridges in flood time to collect and guide drift wood likely to get stuck against bridges.

(4) All the Bhabar tract should be fire-protected except where silvicultural operations necessitate burning.

(5) Grazing should be controlled along the Aie and other rivers. Entire closing of grazing might cause hardship.

(6) Rain-guages should be set up along the Bhutan foothills to keep records of rainfall.

(7) Attempts should be made to control the flow of water into the *dongs* by building sluice-gates which will be of permanent benefit to cultivators.

(8) Prohibition of opening of new *dongs* should be ordered. Old and unnecessary *dongs* should be closed or diverted.

(9) Opening of new cultivation along the rivers north of the line should be suspended for the duration of the war.

Readers are requested to consult their own maps.

EXTRACTS

PREVENTION OF SOIL EROSION BY MEANS OF BROAD BASE TERRACING

By Gilbert Browne

Soil erosion is undoubtedly one of the gravest dangers besetting tropical agriculture to-day. In the writer's opinion it is the most serious of all although in certain seasons drought or devastation by locusts or other troubles may overshadow it. For erosion is not a spasmodic visitation but an ever-present drain upon the soil that becomes more severe and widespread for every year of neglect and will eventually make large areas useless for farming unless it is controlled.

It is interesting to note that the natives of some parts of Nigeria have long practised crude forms of terracing to prevent erosion. On the steeper slopes of the Plateau Province crude, flat-surfaced terraces are still in use and are quite effective. The Plateau people also used a form of contour-terracing and when an agricultural officer was working out a modern system of broad-based terraces recently he found that many of their old water channels ran parallel to his terraces. Also the clean "slice" thrown up by the native plough or "galma" forms a ridge that, except in sandy areas, stands up remarkably to beating rain. This plough is almost identical with those found in ancient Egyptian tombs.

On most European-supervised farms in northern Nigeria some attempt has been made to imitate the native method of erosion-control by making ridges and "bars" to hold up excess water; but it was not realised that the apparently haphazard placing of ridges by the peasant had a relation to the contours of the slope, and consequently the ridges, which were run in straight lines, were often badly placed and of little use. This points to the moral that native methods of cultivation should be closely studied before attempts are made to improve them since they are the result of centuries of experience and often have a sound basis that is not at once apparent.

Modern methods of erosion-control began to be applied in Northern Nigeria about 1935. Briefly, the object in most cases is to allow the soil to absorb as much of the precipitation as possible, and in all cases to carry any surplus water off the land slowly so as to minimise its tendency to carry away soil or to carve out deep channels. The problem has been examined from many angles and many methods are combined in this form of soil conservation, the chief of them being the improvement of soil structure to lessen a soil's "erodibility," the selection of suitable vegetable covers, crop rotation, contour cultivation, strip-cropping and, where these do not suffice, broad-base terracing. This article describes an experiment in broad-base terracing at Daudawa farm near Funtuna in Katsina Province of Northern Nigeria.

Daudawa Farm was started by the Empire Cotton Growing Corporation in 1925 and was run in collaboration with the Agricultural Department until 1941 when it was handed over to the Nigerian Government. During this period the cultivated area of the farm was increased considerably as a result of the introduction of broad-base terracing and the consequent regulation of water, which allowed the

lower levels of the farm to be brought under cultivation; the area finally attained being 900 acres. The annual rainfall averages from 45 to 50 inches, much of it precipitated in heavy storms: as much as 4.5 inches has been recorded in under three hours, though this was unusual. The greater part of the farm lies in one large natural drainage area. The soil is a sandy loam of good quality and for the most part well-drained. In the early years the fertility was well above the average for the district but, despite green manuring and application of farmyard manure, yields gradually decreased by 35 to 40 per cent. The quantity of manure was known to be inadequate but this did not wholly account for the decline in fertility, and it seemed certain that loss of top soil by erosion was playing a large part. In 1935 broad-base terracing was begun in some of the worst eroded areas and an annual programme for this work was laid down. Two or three years later it was found possible, by the maintenance of increased cattle herds and the adoption of better methods of conserving manure, to give larger annual applications of F.W.M. over much more extensive areas of the farm; and a little later a system of grass following and selective cropping was established. The result was that in 1939-1940, the last full year during which the farm was controlled by the Empire Cotton Growing Corporation, yields were 30 to 40 per cent. higher than the previous maximum and in 1940-41 they rose even higher. The writer would not like to assign definitely the relative contribution to this improvement of each remedy applied, but there can be no doubt that broad-base terracing played an important part.

A broad-base terrace is an earth ridge or embankment constructed across the slope of a field, behind which is a broad ditch designed to collect the water from the slopes above. In order that water which cannot be absorbed by the soil may be led off slowly, the embankment and ditch are not on the contour but have a slight slope towards a chosen drainage channel. The embankment is usually 10 to 12 feet wide at the base, according to the amount of water likely to accumulate, and the ditch is of the same width.

It is useless to try to lay down hard and fast rules for broad-base terracing. Textbooks and tables may be useful in giving a general idea of the subject, but every area and almost every terrace needs individual treatment and experience and commonsense soon modify unpractised theory.

The first and most important decision needed is: Where to lead the surplus water? And this must be based on a careful study of the whole drainage area, otherwise damage may be done to ground lying below the terraced slopes. It is generally wisest to use the natural drainage channel if possible, but if damage to the lower slopes is feared it may be necessary to lead at least some of the surplus water to a new drainage area. At Daudawa about half the surplus water was diverted from the natural drainage channel and, as already mentioned, the area of cultivable land was thereby considerably extended.

The first piece of ground to be dealt with was a 20-acre field of which 15 acres were very badly eroded, the surface soil being almost all gone and three deep gullies having developed. The line of the channel for surplus water was chosen and an adequate ditch dug. The next step was to "line out" the terraces and, in accordance with the usual procedure, work was begun at the top of the field. For this

operation a reliable Dumpy level or similar instrument is needed: also two or three hundred good hardwood pegs about 18 inches long with the top six inches whitened, preferably with paint. The position of the first "outfall," or entry point of water from the first terrace to the main ditch, must be chosen, and in doing this the vertical fall from the highest point of the drainage area, and the heaviest pressure likely to come on the terracing running back from the "outfall" must be considered. It is not advisable to be too definite in giving figures, but unless the local conditions are abnormal, a vertical fall of three or four feet between the highest point and the first "outfall" is reasonable as a preliminary choice. A peg is driven at this point on the channel and the planner must next examine the approximate line of the terrace, consider the area that will be drained and the type of ground, and decide whether the proposed terrace can take the water pressure likely to develop, or whether the prospective pressure must be lowered by reducing the vertical fall to the first outfall. The setting out of this first terrace is the most important and a trial line may have to be laid out before fixing the position of the first outfall. When this has been done and a rough idea obtained of the length of the terrace the next step is to decide its gradients. A short terrace may be level or graded uniformly; alternately, it may have an even gradient from near its centre to outfalls at both ends. A long terrace is generally made almost level in its upper part and with steeper gradients towards the outfall, where a greater volume of water has to be disposed of. Gradients should be kept as low as possible, as the higher the gradient, the greater the erosive power of the water: and it may be said that a gradient of 0.40 feet per 100 feet is a maximum that should be used only in exceptional circumstances. The area of land to be drained, its configuration, the character of the soil and the length of the terrace must all be considered, each terrace being an individual problem that can only be worked out by the man on the spot.

The actual laying out of the terrace is simple. The Dumpy Level is set up at the first outfall: a piece of cord equal in length to the intended distance between the "spot" heights, generally 20 to 25 yards, is tied to the first peg and to a graduated staff; and then the staff-man walks the length of the cord and, keeping it taut, moves along the slope uptil the line of the level intersects the staff at the proper height. A peg is driven at this point and the process repeated until the whole terrace has been pegged out. When the staff is at a distance, a narrow white tape can be tied round it as an aid in sighting the level. On a long terrace the level may have to be moved several times. The pegs give the slope of the terrace, but the actual line must have sweeping curves such as can easily be followed by a plough team: these can be marked out on the ground with stones or scrapes, but where a considerable irregularity breaks the terrace gradient the true contour must be followed. Sometimes an irregularity may have to be avoided by laying out a new line, or it may be possible to smooth it out by digging and filling.

Where the "lines" crossed deep gullies, two of which were five feet deep, a strong foundation for the proposed embankment and ditch had to be built. This was done by driving brushwood stakes or "spiles" firmly set into the ground at close intervals, cutting them off about a foot above the terrace level and inter-weaving them with small branches and twigs. Earth was then brought from the bush in

head-pans and cattle-drawn carts and piled up on both sides of the stakes until the dyke was level with the ground on either side of the gully. Later the terraces were built along these dykes, and all the terraces carried across gullies in this way successfully survived the rains.

When the first line is finished, it is decided what vertical fall should be allowed to the next outfall. This depends on the slope of the land, *e.g.*, with a land slope of four feet in 100 feet, a reasonable fall is three feet, giving a distance between terraces of 75 feet. Actually the slopes with which the writer had usually to deal were ones on which a vertical fall of $2\frac{1}{2}$ to $3\frac{1}{2}$ feet gave a distance between outfalls of about 150 feet. The position of the second outfall is found by Dumpy Level and staff and the second terrace is laid out from it exactly as before.

After the whole area to be treated has been marked out and the pegs replaced by marks in the ground, terrace building is begun. In the early days of terracing at Daudawa a Fordson tractor and double-furrow plough were used. With these we "opened up" along the line of pegs as a ploughman would open up a "rigg" at home. The plough was set to throw towards the centre and about ten circuits were made. Then a home-made grader, made of 2-in. planks, was used to push the earth up into a bank. the long leg of the grader being in the furrow against the "land." The grader was later reversed, so that its long leg pushed the earth still higher. The use of a tractor is not essential and is mentioned only as a matter of interest as it is unlikely to be generally feasible in Nigeria for some time to come.

Experience showed that it was better and cheaper to work only from the upper side of the ridge; and in using this method the water channel is dug out by hand and the earth thrown to the lower side of the pegs to form the ridge. The simplest way of doing this is to mark out the width of the channel required on the upper side of the line of pegs and then to dig along the centre a narrow trench of the depth required for the whole channel. This serves as a guide for the labourers, so care must be taken to see that it is properly graded and on the correct line. The sides of the channel are then carefully cut away with a sharp-edged spade leaving the floor smooth and evenly graded. The beds of the water channel should be grassed to prevent wash and scour. Beans, pigeon peas or crops of that nature may be grown on the ridge and help to consolidate the soil. The ridge itself must not be ploughed but cultivation may be brought to the side of the water channel.

When the rains come, a man should be sent daily to find and repair weak places in the terraces and to remove inequalities in the water channel beds. As a rule, the planner of the layout is so interested that he gets many a thorough soaking whilst watching the effects of heavy rainstorms on his work. During the first year's work at Daudawa about 35 acres were terraced. and in the following year 250 acres. The work was continued in succeeding years until, when the farm was handed over to Government in 1941, all the most seriously affected areas, aggregating about 700 acres, had been treated. The surplus water was not led into storage dams, as is frequently done in other countries where there is a shortage of water for cattle in the dry season. The retention of water in such dams might have been a problem, and it was not considered that they would be of much use. The reclamation of land

so badly eroded as parts of Daudawa was inevitably expensive, and it was undertaken partly because the bad areas formed part of a farm that was already established, and partly as an experiment to ascertain whether badly-eroded land *could* be brought back into production.—*Farm and Forest*, Vol. IV, No. 1, dated February, 1943.

MANGO KERNELS AS FOOD

BY E. GORDON WILKINS, M.D., D.T.M. & H.,

Moorshead Memorial Hospital, Baptist Mission, G. Udayagiri, Ganjam.

The practice of using mango kernels for food is common among the inhabitants of the Kond hills, Ganjam Agency. It is also to be found in certain other parts of India, but it does not appear to be widespread. Probably the people were first driven to it by economic necessity. In these hills, many of the poorest subsist very largely on a flour made from the kernels during the "hungry time" from about August or September until the rice harvest in cold weather. But all classes, including those who have plenty of other food, enjoy this addition to their diet during the season. The local method of preparation and the food value of the resulting flour were, therefore, thought to be worth investigation, especially now that it is urgently necessary to make the fullest use of every potential foodstuff.

Method of Preparation.—All mango stones are saved during the mango season. About the end of August they are broken open, and the kernels extracted and soaked in water until next morning. They are then pounded to powder, which is sieved, the coarser particles being pounded again until the whole is fairly finely powdered. The damp powder is put in a wicker basket and pressed down flat. A large number of holes are made with a stick through the mass right down to the basket. The basket is put in a warm place in the house until next morning when it is taken to be washed in running water. This may be a stream, or the water flowing from one terrace of paddy to the next. The water is too muddy in the earlier part of the rains and the people wait until it clears somewhat. The water percolates through the holes and out through the interstices of the basket. Washing is continued until samples of the powder no longer taste astringent. This generally takes half a day, but if by evening the astringent taste persists the whole is discarded. If no running water is available, the washing can be done by repeated dipping in a tank or pool. The powder is spread out to dry and is then eaten in a variety of ways. It is made into cakes, put between green leaves, and lightly baked in the fire. Or it may be mixed and cooked with rice, or made into balls and cooked in hot ashes. Another way is to cover with green leaves and cook in an earthen pot. The flour must be used within a few days as it does not keep well. The cakes are enjoyed by all, and a housewife will often make a batch and share them with the neighbours.

Among the Konds the process is accompanied with various interesting rites and ceremonies. The basket of pounded kernels is regarded with superstitious awe for fear of offending "the old woman of the kernel-flour." After the washing and before

the flour is cooked and eaten, a sample is taken on a leaf and a burning brand is thrust into it while an incantation such as the following is recited:

"The first man who ate you—the first man who drank you,
Make him sick—make him purged!
Oh! We eat you because of hunger,
So make us not sick—and purge us not!!"

This sounds a bit hard on the pioneer who first discovered the process, but he being long since dead is presumed to be out of harm's way!

Food Value.—To ascertain the food value of this flour a sample of the local mango kernels was sent to Dr. W. R. Aykroyd of the Nutrition Research Laboratories, Coonoor. He reported as follows:

"Mango-kernel flour prepared according to the method described in your letter gave the following analysis:

	Per cent.
Moisture	8.74
Protein	5.56
Fat (Ether extractives)	16.13
Mineral matter	0.35
Carbohydrates (by difference)	69.22
Calcium (Ca)	0.09
Phosphorus (P)	0.02
Iron (Fe)	6.49 mg

The figure for "ether extractives" was high. It would, however, scarcely be justifiable to count these as edible fat They consisted largely of a dark, reddish-coloured, unpleasant, smelling, oily substance, the nature of which has not been identified. Since it is not clear how far they would be physiologically utilizable, I have not included a figure for caloric value. Otherwise there is nothing remarkable about the analysis. The protein figure is lower than that given by cereals (except certain varieties of rice) and very much lower than that of pulses and nuts. The content of calcium and phosphorus is not high."

This confirms that the flour has at any rate some food value which is comparable to rice, and possibly greater if the "oily substance" can be used in the body. Though it may be unpleasant when extracted, the Konds find the cakes palatable and they do not seem to cause indigestion. There is some protein, though its biological value has not been worked out.

No Poisons.—The care shown by the Konds in the preparation of mango-kernel flour and their superstitions regarding it made it necessary to determine whether there is any poisonous substance in the kernels that may remain in harmful quantities even after the prolonged washing. The kernels of many fruit stones contain glucosides yielding hydrocyanic acid. Samples both of the untreated kernels and of the flour prepared from them by the Konds were, therefore, sent to the Medical College, Madras, where extensive pharmacological tests were made by the Research

Officer, Sri Venkatachalam, L.M. & S. Tests on the untreated kernels for hydrocyanic acid (free as well as in combination with glucosides), alkaloids and toxalbumins were all negative, and no poisonous substance was found. Dr. Venkatachalam adds: "The extract made from the powder of the untreated mango-seed kernels, however, gave all the reactions for tannins while the prepared flour sent by you, as well as that prepared in this laboratory by the process described in your letter, gave negative results for tannins. Tannins are known to be practically non-toxic and suited for use in the alimentary canal. The belief held by the people of the Kond hills that the seeds may prove poisonous if not properly prepared is probably due to the astringent taste of the seeds on account of the tannins present in them. The washing of the pounded kernels evidently removes the tannin matter and the flour becomes tasty and eatable. I am inclined to believe that this is only a superstitious belief and is not founded on any facts. The fact that raw untreated mango nuts are not poisonous is also borne out by the observations made by Watt in *The Dictionary of the Economic Products of India,* Vol. 5, page 155, wherein it is stated that the kernels powdered when thoroughly dry are made into *chapatties* and used as food in the north-west parts of India."

A Family Food.—Though mango-kernel flour is not to be recommended as a staple diet as used for some months each year by the poorest Konds, yet there is no reason why people should not eke out their supplies of rice with it. The mangoes used are of the wild country variety to be found everywhere in India. Nothing more is required besides saving the stones and washing the pounded kernels until the astringent taste is removed. Stripped of superstition, the process used by the Konds could doubtless be simplified. The poor everywhere could provide themselves with extra food at no cost to themselves. The difficulties of introducing a new article of diet to people unaccustomed to it are well-known, but necessity may force them to eat foods which in normal times they would despise. In famine areas this foodstuff should also be remembered since that which saves the Konds in time of want may benefit others in similar circumstances.

In conclusion, I would thank Dr. W. R. Aykroyd and Dr. K. Venkatachalam for undertaking the food analysis and the pharmacological tests.—*Indian Farming,* Vol. III, No. 12, dated December, 1942.

INDIAN FORESTER

SEPTEMBER, 1943

TYPES OF CHARCOAL KILNS—I

BY K. L. BUDHIRAJA AND A. C. DEY

(*Chemistry and Minor Forest Products Branch, Forest Research Institute, Dehra Dun.*)

The conversion of wood into charcoal is an ancient practice and the original technique followed from time immemorial has remained more or less unaltered, except for a few modifications which were introduced when the value of some of the volatile products from the destructive distillation of wood began to be realised. The ancient methods were the simplest imaginable, though wasteful. The raw material being not costly, the ancient practice still continues to be followed, regardless of waste, even to-day, especially where charcoal is required in small quantities and the volatile products are not cared for. The primitive method, popularly known as the *pit method,* consisted of burning wood in an open pit dug in the ground and subsequent damping off of the burning charcoal with wet earth, leaves, etc. A pit was preferred to burning in the open because the former reduced the area over which the covering had to be made and also minimised the contact with air, and it is round these features that various improvements in the original pit have been devised. The pit was later replaced by "heaps" or "meilers" and further improvements resulted in the carbonization of wood in metal kilns and retorts.

Before describing the various types of charcoal kilns, a brief description and other characteristics of fuel-wood required for the manufacture of charcoal are given: —

Raw Material.—Though every species of wood will carbonize[1], yet the charcoal formed may be so different in its quality as a fuel that selection of a proper type becomes essential. For instance young wood, being richer in sap, is less suitable than mature or old wood. Similarly, the yield of charcoal from wood of large annular rings and wide wood vessels is less and results in lighter charcoal than from the wood of heavier and denser structure. Very old woods (specially *kamala, sal* and *khair*) yield charcoal which is fissured[2], resulting in a great wastage during transport and storage. Similarly, rotten or porous wood gives weak and friable charcoal. Wood containing bark is not very suitable since the bark charcoal increases the ash content and easily crumbles down to dust. Consistent with availability and cost, generally speaking any species of wood with dense structure and narrow annular rings will produce charcoal of good quality for producer-gas plants.

The wood should be cross-cut into lengths to suit the dimensions of the kilns and should be uniform in size, permissible variation being about three inches in diameter. As far as possible, billets of one species only should be used for any one charge but, when different species have to be employed, selection should be made from those which have approximately the same density.

Moisture Content.—A moisture content up to 30—40 per cent. (*i.e.,* 100 parts of wood containing 30—40 parts of moisture by weight) in wood is permissible in carbonization, and wood stripped of its thick bark and allowed to dry (for at least two months after felling) generally attains this moisture content and becomes suitable for charcoal making.

Carbonization of wood[3].—The temperature of carbonization is an important factor exercising great influence on the yield and nature of the charcoal. As a rule, high temperature and rapid operations give small yields and slow combustion at low temperatures results in high yields. If wood is heated to above 150°C. it begins to carbonize. At first, the moisture escapes from the wood after which the volatiles distil off. As the temperature rises and the decomposition of the cellulosic material proceeds, pyroligneous acids, methyl alcohol, acetone, hydrocarbons, carbon monoxide and carbon dioxide make their escape, leaving behind the residue which is charcoal. As the gases and volatiles escape and the temperature rises, the residual charcoal becomes richer and richer in carbon. For example, if wood is heated at 150°C. the Carbon content of the charcoal is only 47.5 per cent. whereas at 1750.°C. it is 96.52 per cent. The following table gives figures for the intermediate stages of heating:

Temperature of carbonizing.	*Carbon content of charcoal produced.*	*Quality of charcoal.*
150°C.	47·51	Imperfectly burnt.
200°C.	51·82	
270°C.	70·45	Readily combustible, brown charcoal.
350°C.	76·64	Black charcoal of good quality.
632°C.	81·64	Very black, dense solid, difficult to ignite.
962°C.	81·97	
1084°C.	83·29	
1200°C.	90·81	
1750°C.	96·52	Very hard, cannot be broken and sparingly combustible.

It will be obvious that the quality of charcoal obtained depends upon the conditions of carbonization. It will also be noticed that the ideal temperature appears to be about 350°C. and the charcoal produced at this temperature contains about 77 per cent. carbon. In actual practice, however, it is difficult to control this and the temperature generally remains between 500—600°C. After the wood has been heated to about 350°C. the process becomes exothermic and the temperature of carbonization rises by itself to over 600°C. giving charcoal which contains about 81 per cent. carbon. But the charcoal obtained at 350°C. is usually richer in volatiles and easier to ignite than that formed at 600°C. Therefore, the temperature of carbonization should be properly regulated so as to yield fully-carbonized charcoal which, at the same time, is not very poor in volatiles.

Yield[4].—The average yield of charcoal ranges between 25—31 per cent. by weight of the original wood calculated on wood of zero moisture. The yield by volume is about 50 per cent. Higher yields than 31 per cent. should be viewed with suspicion for the presence of tarry matter.

Charcoal can be made by any of the following methods:

(*a*) in open pits, (*b*) in kilns, and (*c*) in retorts.

Charcoal-making in retorts forms a part of the destructive disillation of wood. This subject is not being dealt with here and, only pits and kilns are described.

Many types of pits and kilns are used for charcoal-making all the world over and they fall into three major categories:

I.—*Indigenous Kilns*—
- (*a*) Open-pit kiln.
- (*b*) Improved pit-kiln.
- (*c*) Paraboloidal kiln.
- (*d*) Oven-kiln, including brick-walled ovens.
- (*e*) Prismatic kiln.
- (*f*) Hill-kiln.

II.—*Brick-walled Kilns*—
- (*a*) Nilgiri kiln.
- (*b*) Conical brick-kiln.
- (*c*) Siamese kiln.

III.—*Metal Kiln*—

Forest research institute portable charcoal-kiln.

PART I.

Open-pit Kiln.—The practice of charcoal-making in an open pit can be traced back to remote antiquity. It is the most wasteful process and has little in its favour except in places where fuel is plentiful. It has, however, never become obsolete, being the quickest and the simplest of all.

A pit is dug in the ground, of convenient dimensions, averaging about three to five feet in diameter and about five feet deep. The top of the pit is kept narrower than the bottom to facilitate an easy control of the firing Clay or clay-loam soil is the best but if the soil is sandy the walls are lined with bricks, laid in mud mortar, to prevent their falling or crumbling. Dry twigs and thin pieces or split wood placed in a small heap at the bottom of the pit, in the centre, are lit and allowed to burn in free access to air, more split wood being added to make a good fire. Billets not more than eight inches in diameter and about one-and-a-half to two feet in length are then thrown over the fire in such a way as to form a layer without crushing and allowed to burn till the smoke ceases. More wood is then added and the operation is repeated till the pit is full of glowing charcoal. The fire, at this stage, is damped by sprinkling water and the pit is covered up, to exclude air, with damp turf or soil, leaving only an exit hole for the smoke. A piece of corrugated-iron sheet is a convenient material for covering the pit instead of damp earth or turf, etc. The use of corrugated sheets is recommended in preference to flat iron sheets which are apt to buckle at high temperatures. When smoke has ceased, the exit hole or edges (in the case of corrugated sheets) are sealed up with dry earth and the pit allowed to cool. After a day or so, the cover is removed and the charcoal shovelled out.

A yield of about 18 per cent., calculated on wood of zero moisture, may be expected in this type of pit. The charcoal thus obtained is generally not regarded as suitable for producer-gas though, with a little care and control in burning, improvement in quality can be effected.

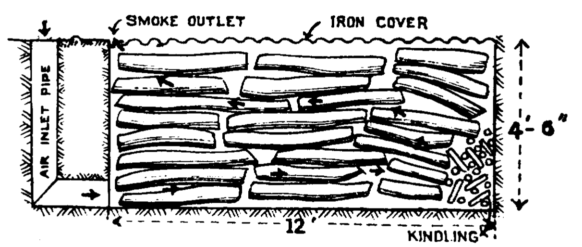
Improved Pit-kiln.—For making charcoal in large quantities, the open pit cannot be employed because in a pit exceeding 100 cubic feet, the carbonization never reaches completion. In such cases an elaborate system of air inlets and smoke outlets has to be provided. Such a pit (which probably originated in China) has recently come into use in Australia and is known as the *Improved Pit-kiln.* The pit is rectangular in shape 12 feet by 4½ feet by 4½ feet. Air enters the pit through two holes, four inches in diameter, from one side of the pit and reaches down to the bottom.

The pit is charged with air-dried wood of about 3 feet length and nine inches diameter. The billets are stacked parallel to the long side of the kiln, thinner pieces are placed at the bottom and the thicker ones at the top and the stacking is done as compactly as possible. After the pit is full, it is covered with corrugated sheets, leaving a gap of about nine inches at either end, one of them being away from the air inlets for firing the kiln and the other near the air inlets for the smoke exit. During stacking, some easily combustible material like dry twigs, split wood, etc., is placed at the bottom of the pit, away from the side having the air inlets. To facilitate firing from the top, three pieces of wood about five feet long are inserted vertically over the kindling, while the stacking is in progress, and after the pit has been stacked these are pulled out, leaving a channel through which burning embers are dropped in to light the kiln. When the kindling has caught fire, the hole is closed with pieces of wood. After about 15 minutes when the fire is well lit, the gap in the roof above the firing end is covered with a corrugated sheet and the edges sealed up with dry earth. The overlapping joints of the sheets are also made air-tight by sealing with dry earth. The smoke now has to make its way along the whole length of the kiln, through the stack, to the other end and escapes through the nine inches gap in the roof. After about half an hour during which large quantities of white smoke issue through the outlet, the width of the smoke outlet is gradually decreased to about half an inch by adjusting the corrugated sheet and resealing the edges, to slow down the rate of carbonization. The burning now proceeds without much further attention, except for closing with dry earth any leaks which might develop at the joints in the roof or at the edges. The burning takes 48 hours, after which the volume of smoke becomes much less and its colour changes to bluish. This is an indication that the carbonization is complete. The smoke outlet is completely closed at this stage by drawing the roof section over it and sealing it up with earth. The air inlets are also closed with wooden plugs or tin caps and made airtight by covering with earth. After about a day or so, when the pit has cooled down completely, the iron sheets, comprising the roof, are taken off and the charcoal removed. The yield of charcoal obtained varies according to the species of wood carbonized, its moisture content, compactness of packing and other factors. The average yield calculated on wood (zero moisture basis) is about 20 per cent. in the case of *chir* (*Pinus longifolia*) and 28 per cent. for *sissoo* (*Dalbergia sissoo*). The quality of the charcoal so produced is good and suitable for use in the producer-gas plant.

Improvements[6] in this type of pit have been suggested. These consist in providing four outlets at different levels for the smoke, two on each side, reaching down to the depths of 1, 2, 3 and 4 feet respectively from the top towards the part of the pit containing the air inlets. Firing of the kiln is carried out as described previously, except that after the wood has caught fire the top of the pit is completely closed with corrugated sheets and sealed. The smoke is allowed to escape through outlets 1 and 2 while 3 and 4 are closed. After some hours, the smoke will cease through the outlet No. 1 when it is closed and No. 3 is opened. Similarly, after a further period, No. 2 is closed and No. 4 opened. Later on outlets 3 and 4 are closed one after the other as soon as the smoke has ceased. Chimneys made of tin sheeting and about three feet tall serve the purpose for the smoke outlets.

During carbonization the corrugated sheets covering the pit become very hot. This heat can profitably be utilized for drying the wood for the next charge. For this purpose, two 12-foot poles with crossers over them are placed along the length of the pit, a little beyond the corrugated sheets, and the wood to be dried is piled on the crossers.

Fig. I



IMPROVED PIT KILN

Paraboloidal Kiln.—The bulk of charcoal in India is made in indigenous mud-walled kilns of which the paraboloidal kiln is the best-known and most commonly used. The following description of the paraboloidal overground kiln has been taken from the "Manual of Indian Forest Utilization," 1940, by H. Trotter, Forest Research Institute, Dehra Dun (Oxford University Press, Calcutta.)

"It is built in the shape of paraboloid, the volume of which is roughly $\pi r^2 \times h/2$, or in terms of the circumference (C) the volume is $C^2H/8\pi$. In size these kilns vary considerably depending on the amount of charcoal required. A convenient size of kiln is one with a radius of 8 to 10 feet and about eight feet high. This gives a capacity of roughly 800 to 1,200 stacked cubic feet.

"*Site.*—The site for a paraboloidal kiln must be level and even, and should be in a sheltered place near to water. The soil should not be too stiff nor too porous, a sandy loam being about right. If too porous, it allows air to penetrate and, if too stiff, it does not absorb the liquid products of carbonization. All vegetation

should be removed by the roots, and the ground should be uniform with the centre of the site raised about eight inches and sloping evenly to the circumference so that any liquid products not absorbed by the soil can run out to the edge. If the site is at all damp, dry leaves or brush-wood should be burnt on it; in fact, the best site of all is an old site which has been previously used for charcoal-burning. Better results are likely to be obtained if a new site is allowed to settle for two or three months before being used, but this is rarely done in practice.

"When taking an old site into use, the small pieces of charcoal found lying on the surface should be broken up and well mixed with soil before it is prepared for use as described above.

"*Building the Kiln.*—This type of kiln is usually built up with two tiers of vertical billets and a top layer of horizontal billets. If the vertical billets are cut three feet long and the horizontal billets are stacked two feet deep, the kiln will then be eight feet high which, as stated above, is a convenient height. Before stacking is begun, it is necessary to construct a flue or chimney up the centre. This is done by driving three stakes into the ground in the centre of the site, the stakes being a foot apart and forming an equilateral triangle. These stakes, which should be at least as high as the top of the kiln, are then bound round with twisted grass so as to form a hollow chimney. This chimney is then filled up with dry grass, straw, twigs and other easily-burnt material.

"This type of kiln may be fired from above or from below. If firing from below is intended, a narrow passage must be left from the centre chimney to the outside of the kiln. This is usually done by laying a straight pole along the ground and stacking billets in the form of an "X" above it, the pole being withdrawn when the stacking is completed, thereby leaving a horizontal flue below the billets. To ensure a correct shape for the kiln, the circumference is marked out on the ground with pegs in the form of a circle.

"Stacking then commences from the centre, with a few thin billets placed round the centre chimney to ensure easy firing. The other billets, all cut to length and trimmed, are then stacked as closely as possible round the centre. The thick end of the billets should always be on the ground, so that the thin ends are sloping slightly inwards, giving the paraboloidal shape to the kiln. The thickest billets should be stacked about half way out from the centre, this being the place where the heat is greatest, and all interspaces should be filled up with small chips and pieces of wood.

"The second tier is stacked in exactly the same way as the first, always bearing in mind the correct slope and shape of the finished pile.

"The third tier is stacked with the billets lying horizontally on the second tier, various lengths being used to give a rounded top to the stack.

"*Covering the Kiln.*—The best covering for a kiln of this type consists of two separate layers. The thinner layer is usually made of turf, green grass, leaves, ferns, or moss, and must be sufficiently thick and well packed to hold up the outer layer which is made of wet earth, or preferably of fine earth and charcoal dust mixed. This outer covering is plastered all over the kiln so as to exclude all air. This type

of covering has been found quite satisfactory as it is fairly substantial and air-tight and, at the same time, it is pliant enough to give slightly as the interior stack subsides during the burning.

"The outer covering is sometimes kept in position by horizontal poles supported by upright forked sticks, two or three tiers sometimes being employed.

"*Firing the Kiln.*—Firing is usually done from the bottom of the kiln, as the fire then spreads quickly outwards and upwards throughout the kiln, whereas the firing from above often results in the fire failing to reach the lowest part, resulting in an incomplete carbonization of the charge. Firing from below is done by pushing a pole, with a bundle of burning straw tied to the end of it, along the passage left for the purpose under the X-stacked billets of the bottom tier. The material in the chimney is thus set alight and the surrounding billets begin to burn. To ensure the kiln being well alight, more dried shavings, straw and chips of wood are pushed into the chimney from the top and when these have burnt up the chimney is filled up with short billets, to prevent the stacked material from falling in. The lighting passage is then also filled up with billets, and if the kiln is well alight the entrance to the firing passage, as well as the top of the chimney, are covered over with grass and mud.

"*The burning of the Kiln.*—When the kiln is well alight, the fire spreads outwards from the centre in the form of an inverted cone with the base gradually widening outwards. Theoretically, burning should proceed evenly all around the kiln but in practice this seldom happens. The first sign that burning is in progress is a bluish grey vapour issuing from the surface of the kiln, and if all is well this is shortly followed by a thick pungent yellowish-brown smoke which continues till carbonization is complete, when a clear blue flame appears all over the kiln.

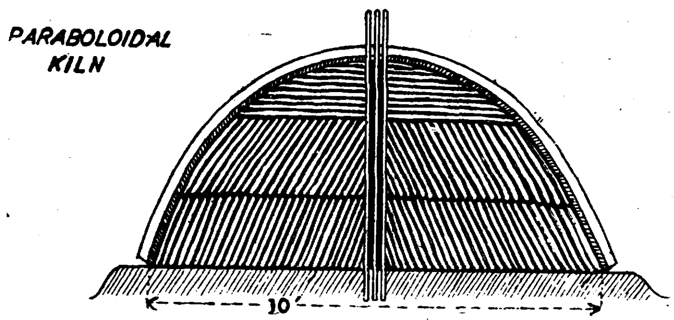
"The time taken to complete carbonization naturally varies with the size of the kiln, the size of the billets and other factors, but the usual period is from 7 to 10 days for a normal kiln. During the whole of this time the progress of the burning has to be carefully watched and controlled and the quality of the charcoal made depends almost entirely on the skill and care of the charcoal burners during this time. If burning proceeds too quickly the outer covering of the kiln has to be thickened. If burning is too slow, small holes are made with a stick, just in front of the line of burning, to allow some air to enter and accelerate combustion. These holes are filled up as soon as a blue flame emerges. In order that the burning may proceed as evenly as possible, the circle of smoke is watched and attempts are made to keep it at the same level by speeding up or retarding the burning as described above. All cracks and hollows formed by the subsidence of the outer covering, due to the loss of volume of the burning stack, must be filled up at once. All this means careful and continual watching, especially at night when cracks are clearly visible by the glow of the fire inside the kiln.

"A screen of branches, leaves, etc., is sometimes erected on the windward side of the kiln to protect it. A strong wind makes control of the burning extremely difficult and screens are frequently erected before the kiln is even lighted.

"*Opening the Kilns.*—When the clear blue flame has appeared right down at the base of the kiln, carbonization is complete, but the kiln is not opened at once

as the charcoal would burst into flames. Very often a week or more is allowed to elapse before the kiln is opened, and even then, the opening is a time of great anxiety and has to be carried out with the utmost care. For this reason the opening is often done at night, when smouldering pieces of charcoal can be seen at once. A small hole is usually made first in the side of the kiln and some charcoal is raked out and the hole quickly covered up. If all is well, this is repeated round the kiln until all the charcoal has been extracted. If any of the extracted charcoal is glowing, it is at once covered with wet earth or sprinkled with a little water. Water should be used sparingly, however, as it spoils the quality of the charcoal. This precaution is often ignored and instances are not uncommon when copious supplies of water are used to quench the charcoal from kilns opened in the heat of the day. When the charcoal is cool enough to handle it is sorted out and put away under cover and the operation is completed."

Fig. II



Oven Kilns.—The oven kilns, usually similar in shape to the paraboloidal kilns, differ from the latter in having a thick covering of mud which becomes baked into a hard crust at the first burning and which is afterwards kept as a permanent kiln. They may be built completely above ground or over a circular hole about two to three feet deep. They are fired through holes in the covering at ground level but the charcoal is always extracted through the same opening in the side of the kiln and the rest of the wall is left intact as a permanent oven. The yield from the first burning is always less than from subsequent charges.

Another type of oven kiln (common in Daphar and Chichawatni plantations, Punjab), with a brick lining, commonly employed for making charcoal in irrigated plantations, has been described by Chopra (CHOPRA, R. S., 1938: *Indian Forester,* 64: 346—48).

Prismatic Kilns—(Rectangular Kiln).—The name is a misnomer. These kilns are really rectangular in shape with rounded sides and deserve to be named *Rectangular Kilns.* The wood is stacked horizontally. Very large kilns of this type are frequently constructed in the Central Provinces. Large logs of wood can be employed without cutting them into billets. These kilns have no chimney and a passage is left along the ground from end to end of the kiln and filled with combustion material. The kiln is fired from either the centre or the ends. A kiln of this type is easy to construct but difficult to cover, the covering being liable to break by uneven settling.

This type of kiln is common in Dehra Dun and neighbouring forests. It is usually 13—20 feet long, five feet broad and five to six feet high. Before constructing the kiln, the ground is cleared of grass, roots, stumps and débris of felled-trees. The base support is then made by placing two long poles, five feet apart, along the length of the kiln in order to keep the stack above the ground. The rest of the wood is stacked crosswise over the base support. The kiln is packed compactly with wood of almost any dimensions within the breadth of the kiln; pieces of two to thirty inches diameter are preferred and usually the thickest material is packed at the bottom and thinnest at the top taking care to make the kiln slightly sloping on one side as shown in the figure.

A firing hole is made by placing three stones in the middle of the broad side of the kiln in such a way as to form an enclosure for the fire. The two long poles of the base support now serve as a flue for the fire to travel to the other end where an exit hole for the smoke has been provided at the top of the sloping side of the kiln. The stack, except the top and fire hole, is now thoroughly covered with brushwood and earth (not mud) which is rammed in well. The top is now covered with leaves one foot thick and this is done to prevent the earth, with which the top is to be covered later on, from falling inside the kiln. The outer covering is kept in position by means of inclined poles and stakes.

Dry fuel is inserted in the firing hole and the fire started, adding more fuel from time to time till it is well lit. Normally the kiln will continue to burn without interruption, after the fire has set in, otherwise the firing in the kiln has to be regulated by opening a few holes on the sides where the wood is not burning properly. As soon as the fire has been drawn in the desired part, the holes are closed.

Sometimes, when the kiln has not been well laid, during burning, the stack suddenly collapses, leading to big openings in places. In such an event, if not immediately repaired, the whole of the stack may burst into flames. The bursting of the kiln into flames may also be brought about whenever there is heavy downpour when the sides get washed away, leaving a big gap.

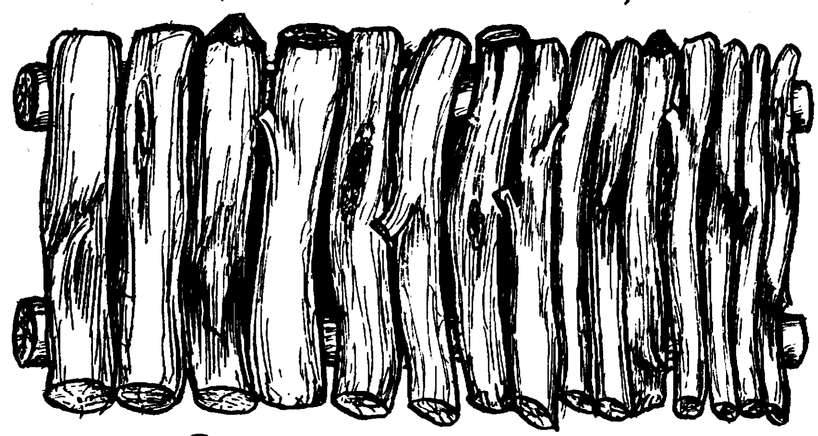
The portion of the stack, where the wood has been converted into charcoal, begins to settle, generally evenly if the stack has been well made. In stacks which are not well made the settling may be sudden, leading to the formation of big crevices. In such cases, the attendant quickly rams in more earth to seal up the crack so formed. Even when the settling is uniform, the attendant has to keep on ramming the portion where the charcoal has formed so that no big air chambers are left. In the portions which have been rammed, a suitable hole is made when the kiln has cooled and a portion of the charcoal is removed. This operation is kept on all round the stack during the period of carbonization till finally there is only a small heap left in the centre and by which time almost the whole of the charcoal has been removed.

Allowing two days for stacking and covering the kiln, seven to eight days for burning and cooling, it generally takes nine to ten days for two coolies to complete one charge for a kiln of 440 cubic-feet capacity.

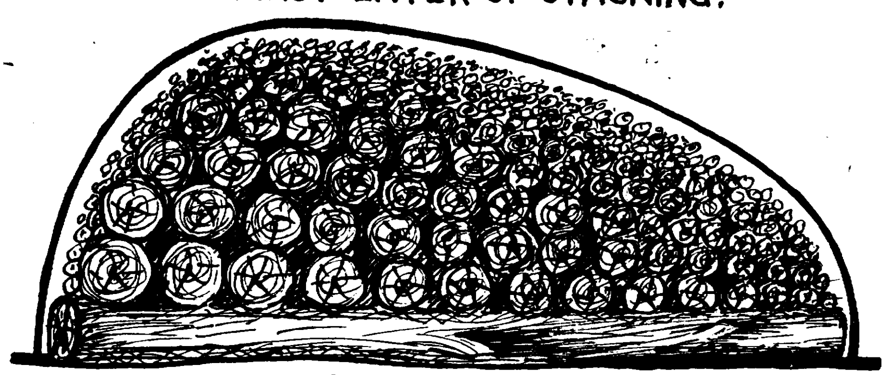
Fig. III

PRISMATIC KILN.

(RECTANGULAR KILN)



FIRST LAYER OF STACKING.



SIDE VIEW.

VIEW OF FIRING HOLE.

A.C.D.
C.K.S.

The charcoal thus prepared is of good quality but usually contains much burnt clay and stones.

Hill Kilns.—Trotter[5] describes them as "merely an adaptation of other types of kilns to suit hilly country where level sites are difficult to find. A cutting is made into the side of the hill so that the ground slopes outwards at an angle of about 60 degrees. The site should be allowed to settle, as the outer portion is usually of made-up earth. A passage is left along the ground from the front to the back, and is used for firing the kilns, and connects with a vent hole at the back. The billets are usually stacked horizontally and, as carbonization is more rapid on the valley side exposed to the wind, the kiln is usually made highest towards the outside, and in this portion the largest billets are stacked. The outer face is frequently supported by horizontal billets held in position by forked sticks. Even if precautions are taken in stacking, burning is apt to be uneven, as the front side of the kiln is exposed to mountain winds while the other side is up against the back of the cutting in the hill side."

(*To be Concluded.*)

LITERATURE CITED

1. KLAR, M., & RULE, A., 1925. "The Technology of Wood Distillation," p. 15 (Chapman and Hall Ltd., London).

2. *Ibid.*, p. 23.

3. RAMASWAMI, S., 1942. "Some Factors affecting the Quality of Charcoal for Producer-gas Plant." *Indian Foester Leaflet* No. 18 : 1-2.

4. LOSEBY, P. J. A., and MERWE, C. C. V. D., 1942. "Modern Methods of Wood Charcoal Manufacture." *Journal of the South-African Forestry Association*, No. 9 : 36.

5. TROTTER, H., 1940. "Manual of Indian Forest Utilization," p. 332; 337 : (Oxford University Press, Calcutta.)

6. CHATURVEDI, M. D., 1943. "The Chinese Charcoal Kiln," *Indian Forester*, 69 (2) : 75—79.

NURSERY DATA AND EARLY GROWTH OF CRYPTOSTEGIA GRANDIFLORA

BY A. L. GRIFFITH

(Central Silviculturist, Forest Research Institute)

Seed data of this plant were given in the July issue on pages 268 and 269. We are now in a position to give details of further stages in the work.

In order to make the best possible use of the seed it was sown in seed-boxes fairly densely, being spread out over the surface of the soil with the seeds almost touching and then covered with a fine sprinkling of earth. The seeds were soaked for 24 hours in cold water before sowing.

Soon after germination had taken place, when the plants were about two inches high and had developed their first pair of leaves, they were transplanted into

(*a*) nursery boxes two feet by two feet by six inches, the plants being spaced at two inches by two inches, and (*b*) into tubes eight inches long and $1\frac{1}{2}$ inches diameter made of oiled paper. At this stage the plants had a tap-root of three to four inches long.

Both methods were very successful and casualties were very few indeed.

Height growth in the nursery has been:

Period from date of sowing.	Average height growth in inches.
28 days	2
42 ,, ...	3
58 ,, ...	8
75 ,, ...	12

During this time in the nursery the tap-root was found to be roughly twice as long as the shoot. It was also found that at all stages in the nursery the seedlings require full light. They are very heliotropic and the growing tips follow the sun round each day. A great deal of the actual growth occurred at night.

In addition, on May 7th we received 20 plants from four to nine inches high from the Horticultural Gardens, New Delhi. These were presumably seedlings about six to eight weeks old but further details of their origin are awaited. Observations on the height growth of these plants showed the following:

Date.	Average height.	Age.
May 7th ..	6″	Probably 50 days.
May 31st ..	10″	74 ,,
June 19th ..	22″	93 ,,
July 20th ..	42″	124 ,,

The best plant is now over six feet high. Growth was thus slow to start with and then very rapid indeed.

The plants were planted out on one acre on July 8th in lines six feet apart with the plants one foot apart in the lines. Along these lines a fence about four feet six inches high for the plants to climb up had previously been erected. This was constructed of posts every six feet made from young teak and sal thinnings. In between these posts bamboo splits were loosely laced.

The plants did not check their growth on being planted out except in the case of a very few small plants of two to three inches high but continued to put on new leaves and make growth. The plants from the boxes were planted out as naked transplants and those in tubes were planted out paper tubes and all.

So far (up to the end of July) casualties have been negligible, being less than ¼ per cent.

It has been noticed that the plants start with an erect habit and begin to climb and also to put out side branches when about 12 to 15 inches high.

Experiments are also in progress with cuttings but it is too early to give any details yet.

NATURE'S SILVICULTURE AS COMPARED WITH THE W.P.O.'s

BY RAI SAHIB A. L. BANERJI, E.A.C.F.

A careful observation of a piece of waste land, which was cultivated heavily in the past, shows that Nature gradually covers it with grass from dormant rootstock. If not interfered with by animals and men, the soil becomes fertilised by the decomposed blades of grass. These seeds of the grass attract birds which, by scraping in search of food, loosen the soil. Pigs and rats also form part of Nature's labour force that loosens the soil. The birds drop seeds of local trees which, by virtue of having had a natural treatment in their stomachs, easily germinate. The land gradually becomes covered with trees of one or more species of all ages.

When the trees grow up and form a canopy, the grass is suppressed, but the rootstock remains alive under the soil. By over-accumulation of decomposed and undecomposed fallen leaves the soil becomes acid and germinating seedlings are unable to take root. Nature's remedy is to make fire by the rubbing of tree branches under the action of continuous strong wind. The fire so caused destroys the acidity and undecomposed leaves and makes the soil fit to receive the seeds.

Birds make their nests in the forest tree crowns and carry on their activity in dropping treated seeds which germinate and grow under the mother trees. The seasonal fall of matured seeds also helps in Nature's forest creation. There are other factors too such as wind and water, which help to disperse seed over wide areas. Slowly the jungle extends its grip over the land.

As the trees grow older and older, the stronger suppress and kill the weaker. In Nature all licing beings must die. The senile monarchs of the forest die and rot, leaving space for the younger ones to grow. This rotation goes on for ever.

But the original formation of forests by Nature takes a very long time. So the W.P.O. is there to hasten the action of Nature. He cannot wait idly to let the grass

grow and the blades die and decompose and fertilise the soil. Nor can he wait for the birds to scrape and loosen the soil and drop seeds. He collects brushwood and useless débris from the nearest forest; stacks it over the land or along the lines where he wants to grow his trees; and then burns it. The ash mixed up with the soil by hoeing or ploughing fertilises the soil in two or three months' time. He collects mature seeds from healthy local trees; treats them artificially, if necessary; and sows them along the burnt lines before the rains break. If he finds that the percentage of germination is too poor or that the young seedlings are too delicate to stand the sun and the rain, he raises the seedlings in a nursery and transplants them later when they are stronger. He tries various methods of planting such as entire seedling planting, dona planting, stump planting, etc., in order to discover the best method of covering the land with trees, with as little delay and expense as possible. When he has established his young forest, he does not wait for the sounder trees to survive after killing out the weaker ones. From the very start he removes the undesirable species by weeding them out. When he finds that the trees have started fighting for survival, he cautiously thins out the weaker ones, in order to let the better trees grow more vigorously.

Nature, mother as she is of all living beings, cannot, perhaps, tolerate the preventive death of the weak. She helps equally both the weaker and the stronger children to survive, though in the long run the stronger children take the lead. But the W.P.O.—Nature's forest manager—kills the weaker in order to favour the stronger children who, he knows, are sure in the end to suppress the weaker ones. He cannot tolerate to watch the gradual miserable process of the death of the weaker ones. Both Nature and the W.P.O. are kind in their own way. The latter cannot afford to wait till the trees get rotten and die. He has to supply the villagers' requirements of timber. So, as soon as the trees are matured, he fells them, providing space for younger trees to grow. If he finds that there is no advance growth of young seedlings, he also burns the undecomposed leaves and prepares the soil to receive seeds. Thus the rotation of the W.P.O.'s forests goes on with his help.

The forest grown by Nature and that grown by the W.P.O. are different. Nature's forest comprises trees of all ages growing together, entangled perhaps with climbers and creepers, while the W.P.O.'s forest usually comprises trees of all ages in separate plots, each plot containing trees of equal age and free from climbers and creepers.

The W.P.O. often does not fell the mother trees all together. He fells them gradually, admitting light to the soil and thereby facilitating the growth of young crops. In the coppice system he keeps "standards" to provide seed for the future crop. By growing trees of equal ages and sizes in separate plots of lands, the W.P.O. supplies, by careful treatment, the maximum amount of timber from a given area to the people and he also fulfils Nature's desire of the eternal continuity of creation.

Yet all over the world it is seen that men and animals of all ages are living together. Does the W.P.O. go against Nature by growing even-aged trees in one and the same area? Will his uniform-aged forests, *viz.*, those worked under the uniform

or coppice system, disappear in time? Is it essential that the W.P.O. must grow trees of equal ages in separate areas?

It is difficult to answer these questions. They have not yet been investigated. It has been noticed that in some of the W.P.O.'s forests the trees tend to become unsound when they attain a girth of $2\frac{1}{2}$ to three feet (at breast-height) while, in the past, sound trees of four to six-foot girth (at breast-height) were common. It is also difficult to say what would have happened if the forests had been left entirely to Nature. But wherever interfered by the action of men and cattle, Nature's forests have been ruined.

Out of the various factors which may be mentioned as the reasons for the degradation of the W.P.O.'s trees, impoverishness of the soil comes first. This is due mainly to the fact that the W.P.O. has to deal with very limited areas of forests which, prior to their being entrusted to his management had been partially destroyed and their soil impoverished by overcutting and overgrazing. In the case of such forests, the W.P.O. has to devise means for meeting the people's demand to the maximum extent possible.

The point is whether Nature likes her land to remain covered with tree growth or bare of trees. It has been noticed that Nature covers even the surface of rocks with mosses which gradually form some soil on which trees may later grow. In an overgrazed and overfelled forest area it is seen that the shoots gradually turn bushy with thorny tips and the area becomes covered with such an impenetrable mass of scrubby jungle that no man or cattle can enter the area. Trees eventually find a refuge inside the scrubby jungle. This proves that Nature wants the land to remain covered with tree growth.

But without grazing land cattle cannot live and without cattle men cannot live. So the W.P.O. fixes the maximum number of cattle that can be allowed to graze in a forest without deteriorating it. Again, man cannot live if the whole world is covered with forest growth. He requires cultivable and homestead lands. At the same time without forest he cannot get his requirements of fuel, timber, bamboos, charcoal, grazing ground and other daily forest-product necessities. The W.P.O's. aim is that at least one-third of the country should remain under forest and that this should be well distributed for proper management.

Nature fails if man interferes with her work and so too, does the W.P.O. The W.P.O. tries to control him by taking the help of the law and by explaining to him the value of forests; Nature on her part curses man with floods, erosion, cyclones, drought, extremes of temperature, famine, epidemics and untimely death of men and cattle.

All lands which have been left waste after a few years' cultivation and all forest areas which now contain nothing but poor bushy growth on deteriorated soil, and all existing unprotected forest lands should therefore, be made over to the W.P.O. for protection and management in order to benefit the people and improve on Nature's handiwork.

DROUGHT IN RELATION TO FORESTRY

BY JAGDAMBA PRASAD,

Experimental Assistant Silviculturist, Forest Research Institute, Dehra Dun.

INTRODUCTION

It has been admitted by all forest workers that drought can be one of the greatest calamities. It is only when we get a drought of great intensity, like the one of 1907 and 1908 in the *Shorea robusta* forests of the United Provinces, that wrapt attention is directed to the problem of dealing with the subject. Nothing can be done to prevent the occurrence, but a number of lessons are learnt in the process of observing and analysing the effects of drought that need stressing in every-day practice both in the field of artificial regeneration and in the management of the forest estate. This note has been prepared with the object of collecting in one place all remarks relevant to our topic that have been recorded in connection with the more important occurrences of drought from the forest point of view, and of indicating, as far as is possible, what can be done in the way of collecting further useful information.

NATURE OF DROUGHT

An ordinary definition of drought in the English language would refer to months of dryness at periods when the ordinary average rainfall is received (8). Drought or dryness is want of rain or water. By drought in forestry we do not mean just the failure of the rainfall in a given year, but rather the failure of the water supply to the forest crop due to a succession of years of scanty rainfall, culminating in the year in which the trees are unable to cope with the conditions of abnormal moisture deficiency (1). Drought is of course due to greatly subnormal precipitation. But that is not the whole story. Thus, for a number of years prior to 1934 (AMERICA), the precipitation was somewhat below normal and during these years the soil moisture supplies were greatly depleted. The extreme losses that occurred during the summer of 1934 could not, therefore, be attributed solely to the severe drought of that year. More properly should they be regarded as the result of a series of successive dry years culminated by the most critical conditions, in so far as vegetation was concerned. The effect may be regarded as a great natural experiment from which sound principles may be developed, the survival figures furnishing a satisfactory basis for the choice of tree species for planting and cultural practices (5). This view is an advance on the one previously enunciated, but even so does not cover all aspects of the problem.

Trees can no more live without water than can animals. Indeed, trees and humans are not unlike in this respect. Both are living organisms made up of protoplasm and living cells. There is this difference however. The food of animals is made for them. Trees must make their own food. The soil minerals essential to tree growth are brought into the tree in water solution through the roots, and water is vital to the process by which the leaves assimilate carbon and oxygen from the air. The amount of water that a tree uses and throws off by evaporation during a summer's day is really astounding. A good-sized fruit tree for example may use from 50 to 100 gallons, while a large forest tree may eliminate two or three times that amount every 24 hours. To deprive a tree of water is thus to take from it an element vital to its food-making and growth processes (3).

EFFECTS OF DROUGHT

Trees.—Trees may either have their tops affected or they may be killed outright. Drought is in fact the prime cause of standing dead trees in natural forest. The severe drought of 1910 in Baluchistan caused the death of many junipers, which are found on dry hills with low rainfall, the effect being increased by the denudation of the undergrowth and subsequent erosion (4). The damage, however, is equally likely in plantations. In Puri (Orissa) drought caused heavy casualties estimated at 10 per cent. of the total plantation area of *Casuarina*, teak and bamboo plantations. In Hazaribagh (Bihar) drought was responsible for the partial failure of bamboo and *Dalbergia latifolia* plantations.

Older and less thrifty individuals begin to die at the top and become stag-headed. Smaller trees are more likely to be killed outright. Conifers whose leaves and buds have dried up cannot recover (3). In the case of *Shorea robusta* the first indication is the scanty foliage put on by the trees as a result of the scanty rains of the previous season. If the drought does occur in that year extensive drying up of trees takes place (10).

There is an apparent conflict of opinion about the incidence of drought on individual trees, *e.g.*, *Shorea robusta* trees three feet six inches in girth suffered most, those over six feet in girth also suffered considerably while small trees were least affected in the drought of 1907-1908 (10). In 1931-32 in the North Kheri division what happened was the reverse of that mentioned by TROUP, the greatest casualties occurring among the all-important saplings and poles. The graphs of well measurements suggested that although there had not been any great fall in the *average* depth of the wells, there had been for the last few years a considerable falling off in the height to which the wells rose after the monsoon in November.

It is believed however that the number of dead trees (AMERICA) is much smaller than appearances would lead one to believe. None of the foresters in the states where the drought occurred placed the loss of large trees in excess of one per cent. The mortality of small trees was much heavier, however (3).

Mature or semi-mature standards of *Shorea robusta* in Sambalpur (Orissa) in coppice tend to become stag-headed occasionally. This is also the experience of the writer in the forests of the old North Raipur division (Central Provinces). It is possible that this is partly due to drought, but is more likely to be due to a small root system incapable of fully supporting a crown suddenly exposed to full possibilities of development so that it resorts to epicormic branches instead.

Drought killed back teak very extensively over 600 square miles in the Panchmahals district of Bombay in 1899-1900 and though much of it sent up new shoots when cut back, many of these died later. The effects continued for at least five years.

In Angul (Orissa) unsoundness in *Shorea robusta* over four feet in girth at breast height was attributed to drought.

Regeneration.—Drought is specially lethal in effect to young regeneration. Billions of little seedlings (AMERICA) unnoticeable to the layman poke their heads through the humus of field and forest and struggle for a foothold on life. With these little wildings—the trees of the future—the drought plays havoc (3).

Indian experience is specially concurrent with regard to the regeneration of *Shorea robusta*. Considerable damage was reported to *Shorea robusta* natural

regeneration in Saranda (Bihar) owing to the late outbreak of the monsoon. OSMASTON took the extreme view for Sambalpur when he stated that drought probably affects only the seedlings.

Grasses.—Grasses are perhaps the worst sufferers in the undergrowth. A large percentage of the native grasses in the central and southern great plains (AMERICA) was killed by the drought of 1933-34. The surviving plants were rather uniformly distributed, however, and were expected to recover rapidly under favourable climatic conditions (2).

Miscellaneous.—Drought may lead to severe damage from fires and insects. To American foresters the drought of 1930 brought about a greater and more serious menace—that of acute and abnormal fires (3). American foresters reported that even in the year of the drought there were evidences that the drought was aiding and abetting the work of tree insects. There is thus the possibility of abnormal epidemics of tree-killing insects, stimulated by a rich harvest of trees too weak to throw off the bugs (3).

REMEDIAL MEASURES

AFTER A DROUGHT

With forests, treatment of individual trees (AMERICA) is costly and usually impracticable, because of the numbers involved (3). Fellings of the dead wood should be undertaken under departmental control, as far as possible, because little can be done to mitigate the evil at this time. Caution should, however, be exercised in the removal of drought-affected trees and trees likely to recover should be left standing. There are instances of recovery in the case of two of the most important Indian timber species. In the case of the teak, in the Central Provinces in 1924-25 the effects of the drought of 1920-21 were still evident in the case of stems whose leaders died outright, but otherwise recovery was complete and the dead branches fully replaced by 1924-25. In the case of *Shorea robusta* the plot near Khapa in Balaghat (Central Provinces) in which registered trees dying back from their tops due to drought were kept under observation showed a remarkable recovery in four to five years.

PROPHYLACTIC

Methods of treatment.—For *Shorea robusta* TROUP showed the superiority of high forest over coppice with standards (10). This was questioned in the Pilibhit working plan (U.P.) by HALL, who stated that in forest management it is impossible to legislate for every possible disaster that might happen to the forests and although it may be granted that severe drought is a danger to *Shorea robusta* particularly when worked under a system of coppice with standards, it is not sufficiently great to discard the system as impracticable. It can safely be argued that considerations on account of damage likely to result from drought should not outbalance other objects of management but if other things are equal as between two rival systems, the casting vote, as it were, should be given against the system of coppice with standards for drought-tender species and for areas liable to phenomenal damage from drought.

Favouring or selection of drought hardy species.—The next step is the encouragement of species hardy to drought. The following is a list of species compiled from available sources for guidance and correction as necessary in the light of unpublished and future experience.

I—Species conspicuously hardy to drought

Anonaceæ—	1.	*Miliusa velutina.*
Bignoniaceæ—	2.	*Stereospermum suaveolens.*
Ebenaceæ—	3.	*Diospyros melanoxylon.*
	4.	*Diospyros tomentosa.*
Moraceæ—	5.	*Ficus bengalensis.*
	6.	*Ficus religiosa.*

Exotics

Elæaganaceæ—	7.	*Elæagnus angustifolia.* (The Russian olive, withstands drought and alkali.)
Fagaceæ—	8.	*Quercus macrocarpa* (The fur oak.)
Leguminosæ—	9.	*Acacia decurrens.*
	10.	*Robinia pseudo-acacia* (Valuable for control of soil erosion. Suckers abundantly from roots.)
Myrtaceæ—	1.	*Eucalyptus globulus.*
Sabiaceæ—	12.	*Populus deltoides.* (Drought resistant in youth.)
Ulmaceæ—	13.	*Ulmus americana* (Excellent shade tree).

II—Species decidedly hardy to drought

Anacardiaceæ—	1.	*Lannea grandis.*
Apocynaceæ—	2.	*Carissa spinarum.*
	3.	*Holarrhena antidysenterica.*
Boraginaceæ—	4.	*Cordia myxa.*
	5.	*Ehretia laevis.*
Euphorbiaceæ—	6.	*Bridelia retusa.*
	7.	*Mallotus philippinensis.*
Leguminosæ—	8.	*Bauhinia racemosa.*
	9.	*Butea frondosa.*
	10.	*Cassia fistula.*
	11.	*Ougeinia dalbergioides.*
Lythraceæ—	12.	*Lagerstrœmia parviflora.*
Malvaceæ—	13.	*Kydia calycina.*
Myrtaceæ—	14.	*Careya arborea.*
	15.	*Eugenia jambolana.*
Rhamnaceæ—	16.	*Zizyphus xylopyrus.*
Rubiaceæ—	17.	*Gardenia turgida.*
	18.	*Randia dumetorum.*
	19.	*Randia uliginosa.*
Rutaceæ—	20.	*Aegle marmelos.*
Samydaceæ—	21.	*Casearia tomentosa.*
Sapindaceæ—	22.	*Schleichera trijuga.*

III—Species fairly hardy to drought

Apocynaceæ—	1.	*Wrightia tomentosa.*
Combretaceæ—	2.	*Terminalia belerica.*
Leguminosæ—	3.	*Albizzia procera.*
Rubiaceæ—	4.	*Adina cordifolia.*
	5.	*Mitragyna parvifolia.*

IV—Drought tender species

Anacardiaceæ—	1.	*Mangifera indica.*
Combretaceæ—	2.	*Anogeissus latifolia.*
	3.	*Terminalia tomentosa.*
Dipterocarpaceæ—	4.	*Shorea robusta.*
Sapotaceæ—	5.	*Bassia latifolia.*

Soil Factors.—Soil factors exercise a certain amount of control in combating damage from drought, of which the following are two examples. Advantage can be taken of this and similar information in afforestation work.

Less drought injury to trees has been observed (AMERICA) on dry, sandy, stony mountain soils than on the shale hill soils and fertile agricultural areas. The only injury found on the sandy stony mountain soils is where reflected and radiated heat has burned the foliage. The water content of clay and loam soils is always greater than that of sandy, stony mountain soils, but much of the moisture in the former is held hygroscopically by the fine soil particles and the roots are unable to extract it.

Ashes and walnuts thus show injury on shale hill soils, but apparently none on the sandy mountain soils (3).

Nursery and pot cultures of *Pinus resinosa* (AMERICA) seedlings in their second growing season were supplied with various amounts of nitrogen, phosphate and water. Drought resistance regularly fell with increase in the nitrogen supply. Effect of phosphate supply varied with the amount of nitrogen present. If nitrogen was absent, increase in the phosphate supply gave improved drought resistance; in the presence of nitrogen the same tendency was noticeable, but the optimum P: N ratio was not determined (7).

Hardening in Nursery.—A certain amount of hardening against drought can be imparted to seedlings in the nursery.

According to CHALK tests done in Europe showed that an increased resistance to drought could definitely be produced by raising seedlings in a nursery under extremely dry conditions for one or two years.

Coniferous seedlings grown in a soil deficient in moisture (AMERICA) survived drought longer than those grown in a wet soil. The drought resistance of seedlings of Lake states pines, namely, red pine (*Pinus resinosa*), northern white pine (*Pinus strobus*) and jack pine (*Pinus banksiana*) was thus increased by subjecting the seedlings to moderate soil drought during the period of vegetative activity. Resistance built up in red pine through controlled watering during the second year in the nursery persisted to a significant degree during the following season. The controlled watering amounted to a shortage of 54.3 per cent. for two-year nursery seedlings and 43.7 per cent. for transplants in comparison with the control (6).

OBJECTS OF FUTURE RESEARCH ON DROUGHT

The first step to take is a survey, however incomplete in the beginning, of the precise areas of forest where drought has proved lethal to forest growth on sufficiently large areas to be worth the attention to be paid to them in future management. These areas should preferably be grouped with frost liable areas for special treatment in plans of management. The next step is the discovery of local species of economic importance that can withstand the drought in the area and then of the trial of suitable exotics if necessary.

Information as to the species that seem capable of recovery from the effects of drought is of great value in regulating drought fellings which not only throw the normal prescriptions out of gear but endanger the stability of the forest type by heavy fellings that the drought necessitates.

REFERENCES TO LITERATURE

1. ANON, 1911. "The influence of forests on drought." *Indian Forester* XXXVII (9).
2. ANON, 1937. "Drought survival of native grass species in the Central and Southern great plains, 1935." *Technical Buletin* No. 549.'
3. BUTLER, O., 1930. "What the drought has done to trees." *American Forests*: 36 (11).
4. HOWARD, S. H., 1940. "Note on a tour of inspection of Baluchistan."
5. SCHMITZ, M. E. D. & H., 1936. "Drought damage to prairie shelterbelts in Minnesota." University of Minnesota. *Agri. Exptl. Station Bulletin*. 329.
6. SHIRLEY, H. L. & MEULI, L. J., 1939. "Influence of moisture supply on drought resistance of conifers." *Journal of agricultural research*, Vol. 59 (1).
7. ——————. "The influence of soil nutrients on drought resistance of two-year old red pine." Amer. J. Bot. 26. Lake States Forest Exptl. Station.
8. STEBBING, E. P., 1938. Man-made Desert in Africa—erosion and drought *Indian Forester* LXIV (6).
9. STILES, E. & MELCHERS, L. E., 1935. "The drought of 1934 and its effect on trees in Kansas." Trans. *Kansas. Acad. Sci* 38.
10. TROUP, R. S., 1913. "A note on the causes and effects of the drought of 1907 and 1908 on the Sal forests of the U. P." *Forest Bulletin* No. 22. Supdt., Govt. Printing, Calcutta.

EXTRACTS

THE TRAINING OF FORESTERS FOR POST-WAR AFFORESTATION ON PRIVATE ESTATES

By F. J. Green

Many people in this country do not realize the extent to which the nation is indebted to private woodland estate owners for the vast amount of timber that has been and is being produced by these estate owners to meet the exigencies of the war.

The average layman has no conception of the total acreage of woodlands that have been established in England, Scotland and Wales, by the present owners and their predecessors. The total is about 3,000,000 acres and since the outbreak of the war approximately 1,000,000 acres have been felled.

The Forestry Commission came into existence in 1918-19, since when that department has planted 400,000 acres for the State. Naturally very little of this timber is suitable for the present emergency, although it is anticipated that 70,000 to 80,000 acres will be cleared or thinned and utilized in the mining industry. Although a certain quantity of timber is being imported into this country, further great calls will have to be made on the woodlands, and this demand will continue for the duration of the war. It is, therefore, easy to visualize the enormous acreage that will have to be reafforested after the war. To accomplish this work many hundreds of well-trained foresters will be required, not only for controlling the replanting, but also for the treatment and maintenance of existing woodlands.

A Post-War Forest Policy in relation to private woodlands is being formulated by the Government. In view of the undeniable fact that the great bulk of the woodlands in his country belong to private owners, is it too much to ask, or expect, that these owners, their representatives or the Forestry Societies, with which they are associated, should have a voice in framing or outlining any Post-War Afforestation Policy, which would include the vital problem of forestry education; or should it be the prerogative of the existing State Forestry Authority?

Surely woodland owners are entitled to and should have ample representation on the council of any newly-constituted Forest Authority, for any such new authority would be instituted on behalf of those owners for the sole purpose of encouraging and assisting private forestry, according to the conditions governing the inauguration of the Authority.

My profession brings me into close association with many estate owners throughout the country and all of them have expressed a desire that that vast body should be amply represented on any Post-War Forest Authority that may be set up, and also, above all, that the existing State Forestry Service and any future Forest Authority for dealing with private estates should be distinct and separate forestry services. With these sentiments I entirely agree.

Many errors of judgment and planting mistakes have been made in the past, but these errors are not confined to private estates and they are due to inexperience. Mistakes will never be eradicated, but,, in order to reduce them to the minimum, very careful consideration must be given to the training of foresters.

There are several prevalent ideas concerning this problem of forestry training. Some favour scientific foresters such as graduates of university schools of forestry. These men undoubtedly do have extensive knowledge of the sciences allied to forestry, but lack practical experience and intimate association with woodlands. The more one comes into contact with nature the more one realizes that where forestry is concerned text-book knowledge and practice do not always go hand in hand.

I do not decry the scientific forester, but in order to prevent errors in the future, I would make it a condition of training that much more attention and time should be devoted to the practical operations associated with forestry, and the treatment of woodlands, especially thinnings—at least, so far as the woodlands of this country are concerned. I am aware that undergraduates studying forestry do, or are expected to, gain experience in these operations during the vacations, but I doubt whether this particular study is taken seriously. As this grade of forester would be engaged on advisory work dealing with the treatment of woodlands—advice which means the making or marring of plantations—special facilities must be provided for training these potential foresters in this most critical branch of forestry. It is only by actual and long association with woodlands that this knowledge can be gained. However, this matter will be referred to again.

Another class of foresters favoured by many people is what may be termed the practical forester. This class consists of men who have spent their lives since early youth in the woods and have had extensive practice in all forestry operations from the propagation of trees, through the various stages of growth, to the conversion of the timber. Many of these men have studied and gained a technical knowledge sufficient to cope with all problems that may occur. For estate purposes I consider these men as being the ideal foresters' class; the best of whom be eminently suitable for filling positions as district officers and so forming the nucleus of that grade.

Unfortunately there are insufficient men of this grade to fill the numerous vacancies that will occur when a post-war policy of afforestation is inaugurated, and

consequently immediate steps must be taken for affording facilities for training suitable men. As the training would cover a minimum period of two years this is the first problem that will have to be considered and arrangements must be made for the provision of a suitable training centre or centres where experience in all practical forestry operations can be carried out, and where experience in the care and treatment of woodlands may be gained. In connection with the treatment of woodlands I cannot too strongly emphasize the importance of actual experience of thinning, for many most promising plantations have been ruined by long delayed or too drastic thinning.

The question that now arises is that of recruitment for the forestry service. In the past suitable youths and young men have had very little encouragement to devote their lives to forestry. Remuneration has been slight, as wages for woodmen have been based on the prevailing local agricultural rates, whilst foresters, with few exceptions, have received a mere pittance, incommensurate with the knowledge and work they have to undertake—for forestry is a highly skilled profession.

It is due to these low wages and lack of encouragement that suitable boys and young men have migrated to the towns from the rural districts. I have sought the reason for this migration and the unanimous answer may be summed up in a few words: "Give these youngsters the prospects of a decent living and family life and they will remain on the land."

Wages for landworkers have increased within the last two years, and this does provide a certain amount of encouragement to potential woodmen, but the foresters' emoluments must be compatible with this increase in the woodmen's wages—the average increase throughout the country being approximately 60 per cent. above the pre-war level.

Without doubt, after the cessation of the war, there will be a rush to work on the land such as occurred in 1918-19, and amongst these there may be men who strayed from the land in pre-war days and who are desirous of returning to forestry now that wages have improved.

Then there are the village boys. The best of these should be encouraged, and it should not be difficult to organize methods of propaganda throughout the village schools in the country with the sanction of the County Educational Authorities. Lectures should be given aided by illustrated lantern slides or films in various villages. Annual competitions for school children, such as essays on trees, should be held. This has been done spasmodically, and having examined the essays in one County competition, I was astounded at the knowledge of the subject and intelligence shown by children between the ages of 10 and 14.

Owing to the great difference in the total acreages of woodlands on various estates, it is obvious that the duties and salaries of estate foresters would differ very considerably, but nevertheless all entrants to forestry training centres should be accorded the same opportunities for learning and study, since foresters in the lower grades would no doubt improve their positions as vacancies occur in the higher grades.

Therefore, in order to meet the requirements of individual estates, there should be several grades of foresters which I would designate:

A.—District Officers.

B.—Foresters' Grade 1—For the large woodland estates.

C.—Foresters' Grade 2—For the medium-sized woodland estates.

D.—Assistant Foresters—For the small woodland estates.

The training and qualifications for these various grades should, in my opinion, be as follows:

District Officers.—The functions and duties of these officers would be more or less similar to the existing district officers' class of the Forestry Commission. Selected graduates of a University School of Forestry would be suitable for this grade provided they possess practical experience of all forestry operations. I would, however, make it obligatory that one of their qualifications should be twelve months' practical experience at a forestry training centre or on an approved estate. I would also make it a condition of appointment to this grade that all University graduate entrants be placed on probation for a period of twelve months before being appointed to the permanent staff and that most of this time should be spent with an experienced officer when visiting estates for the purpose of forming plans for the establishment, maintenance, and control, or for giving advice on forestry operations. Such knowledge can only be gained by actual experience as forestry conditions vary so considerably in different parts of the country. As the late Professor Henry once remarked: "Forestry cannot be learned in twelve months; it is a life-long study." Text-book knowledge alone is often very misleading and dangerous.

The best of the younger estate foresters should, as previously mentioned, be included in this grade, and any successful candidates in the school's diploma examinations for foresters who show exceptional merit should be selected for this class. Promotion should be open to all foresters and not be confined to a favoured few.

Foresters in this district officer grade would be appointed by and come under the control of the new Forest Authority. The selection committee—which should not necessarily be entirely composed of State Officials—should include amongst its number some well-known foresters—men who are in touch with estate foresters and forestry conditions throughout the country.

Estate Foresters.—The training and conditions of training for all grades of estate foresters should be the same. Applicants for entrance to a training centre should be between 18 and 25 years of age and have had at least four years' actual experience of practical forestry before submitting their applications for consideration by the selection committee.

Two years should be given for training which would be confined to further experience of practical work, including sawmill operations, and to the study of technical subjects, such as Forest Entomology, Mycology, etc., to enable the students to cope with the several problems which may arise later in the course of their duties

as foresters. Extensive knowledge of these subjects is unnecessary, but a knowledge sufficient to identify common forest pests, the damage caused thereby, and the measures to be taken for eradication, is desirable.

In view of the fact that the marketing of woodland produce is likely to become one of the chief factors of any post-war forest policy, the future centre or centres of forestry training should contain facilities for obtaining practical experience in saw-milling operations and conversion of timber.

The minimum standard of knowledge to be aimed at should be that as set for the Royal English Forestry Society's Woodman's Certificate and Forester's Diploma examinations. The syllabus of these examinations should be revised, and more consideration given to costings, elementary book-keeping, and the measuring, valuing, marketing, utilization and conversion of timber.

In order to qualify for the Forester's diploma, candidates should have passed the Woodman's Certificate examination at least twelve months prior to their entering for the diploma examination.

My experience as an examiner and also that of my co-examiner in the recent examinations was that the candidates showed a lamentable lack of the fundamentals pertaining to forestry, and costings.

In awarding the Society's forestry diploma, I would grade the diplomas A, B, and Assistant forester, according to the results of the examinations after deciding the percentage of marks required for a pass.

Whilst undergoing the course of training, students should receive reasonable wages for the work they perform, less the cost of their board and lodging.

Short Courses for Estate Owners, Land Agents and Foresters.—Short refresher courses for estate owners and land agents on similar lines to those instituted by the Royal Agricultural College, Cirencester, and a continuance of the short courses for foresters extending over periods of three months, which were instituted by the Society with the approval of the Forestry Commission, should be encouraged and extended, for from all accounts they have proved of great benefit to those who took advantage of the opportunities provided for refreshing their forestry knowledge.

Training Centres.—The ideal training centre would, of course, be a private woodland estate where the woodlands are extensive, and contain both conifer and hardwood plantations of the uneven age classes worked on a long rotation. With a suitable sawmill installed such woods would provide material for undertaking every kind of forestry operation, from the propagation of trees and through all stages of their growth, down to the conversion of the matured produce.

With the clearances of woods to meet war requirements it is difficult to foretell what will be the condition of our woodland areas when hostilities cease. As this question of post-war training is of the greatest vital importance to the nation, provid ed such a suitable area is available, should it not be reserved for this great national work?

It is possible that an estate owner would be prepared to lease his woodlands for this purpose on agreed terms, whereby he retained the sporting rights and received the benefits resulting from the improved management of his woodlands. On the other hand, it may be considered desirable that any forthcoming suitable estate should be purchased outright by the Forest Authority.

In either case good living accommodation would have to be provided so that the students would be made comfortable and contented, conditions that would be appreciated and which are necessary to assure serious study.—*Quarterly Journal of Forestry*, January, 1943.

FOREST ECONOMICS—OLD AND NEW

By H. L. Edlin

In the South of England, something still remains of the original open forest of our ancestors, so that a ray of light is shed on their forest utilisation and sense of values. Old books and local histories are invaluable in showing what the planters of our present day timber had in mind, and how far they were guided by the past of their own day, or by its future.

In prehistoric times and down to the early middle ages, timber had little or no economic value in Britain. Supply exceeded demand, and the forester's only concern was with other products, as is well shown by Canute's forest laws. The chief of these products was the vension, a term covering game in general. Historians are apt to project the ideas of their own time back into the past, and so a belief has grown up that the deer of British forests were preserved for sport. So they were in later centuries, but in Norman times the killing of the King's game was often entrusted to his servingmen, such as his huntsmen, fowler or warrener. The great value of game was as a source of meat in winter, which was difficult to obtain under the primitive agriculture then practised. There could never be enough for even the limited population of those days; hence the stringency of the forest laws as regards the killing of deer preserved for the nobles only.

But if the commoner, as opposed to the lord of the manor, could not look upon the forest as his meat reserve, it was useful and even essential to him in other ways. His own enclosed lands were limited in area, for before the days of wire fencing, inclosure was a slow process, and in the southern counties even now has not reached its full extent. The pasturage of his cattle, sheep, pigs and geese was therefore entrusted to "herds," who took out the village flocks to the most suitable feeding grounds on down, marsh or woodland. Of these the shepherd alone survives on certain of the Wiltshire downs.

Other rights of the commoner were the cutting of bracken for bedding stock, turves and brushwood for fuel, heather for use in building "cob" walls, and reeds for thatching. Surface minerals were often important in primitive rural economy, especially chalk or marl for liming sour soils: these varied naturally with the geological formations, the rights of the Dean Forest "free miners" being a curious survival of what was once a general custom. Stone for walls and buildings, and turf for dykes were also useful at times when enclosed fields were being extended. Some

details of these customs of husbandry may be gleaned from Gilbert White's *Natural History of Selborne.*

All this seems far removed from modern forestry, but it goes a long way to explain the disappearance of the ancient forests. There is no better way of postponing natural regeneration indefinitely than scything the tops off each year's seedlings, whilst gathering a load of autumn bracken. Grazing is equally effective, and explains how the old forests disappeared, whereas modern enclosed woodlands, even where clear-felled and abandoned, still persist tenaciously as coppice or scrub. In general, the areas enclosed for agriculture were those from which grazing had removed every tree, thus the difficulty caused by stumps, etc., was obviated.

The value of oak timber and of mature ash, as articles of commerce, were first legally recognised in Britain by a statute of Edward I. in 1245. Young ash might be cut at will, however, so mature ash, in the course of years, became scarce from lack of recruitment. There is a common in Dorset where the villagers may cut any tree that they can carry away. Of course, there are no trees on it; all were cut before they grew too big to be carried! Once, no doubt, it was a forest, and this lack of foresight in allowing the removal of "timber" at an economic stage is typical of forestal economy in times and places when mature timber is not in high demand. The legal interpretation of timber as "ash, oak and elm," which survived almost to the present day, is another instance.

The coppice-with-standards system, and the Crown plantations for naval shipbuilding, are too well known to enlarge on here. But it is sometimes forgotten that between them they met the needs of a rural England right down to the Industrial Revolution. Doubtless, towards the end of that period, the capital of the forests was consumed as well as the revenue, but there is a strict limit to the length of time that such a process can go on.

The decline of British forests during the hundred years following on the Napoleonic wars was due to complex factors, such as transport costs, lack of softwoods, unrestricted free trade, and the apparent impossibility of fully meeting the timber requirements of the growing population from our own dwindling resources. Wooded estates came into the hands of merchant princes to whom their financial yields were quite unimpressive, but who found their sporting amenities invaluable. As a result the gamekeeper usurped the forester's position, and the latter degenerated into a glorified gardener. The wheel had turned full circle until woodlands were mere game preserves, but the game was for sport and not for food, and the wood lands were wholly outside the sphere of normal economics.

Parallel with this was the desire to create and preserve purely ornamental woodlands, for private or public enjoyment. The crowded towns, dependent on foreign imports of timber, sent forth reactionaries who urged that recreational needs demanded the preservation of every old tree and tract of wasted country, and with no memory of rural changes, expected Nature and time itself to stand still in the woodlands.

In some cases the forester has been able to adapt his material to changing demand; in others the past of his woodlands set him a hopeless task. Oakwoods, designed to supply navy timber, are attractive, in their prime, to the nature lover; but

they afford poor cover for game, and their timber is difficult to fit into the modern commercial layout. On the other hand, conifers planted purely as windbreaks now supply valued timber.

Future forests will supply needs unknown to the past, and in new ways. Tractors and motor haulage cut right across the barrier of horse transport and high rail rates which prevented home grown timber competing with water borne imports. The utilisation of woodland products, first the concern of the farmer, then of the sawyer, carpenter, and the turner, is now a matter for the technician and the industrial chemist.

The old utilisation remains, but ceases to be of economic significance, and the forests will remain, adapting themselves to changing needs under the skilful hands of foresters mindful of the needs of to-morrow. Forest valuation on orthodox lines thus appears something of a lottery; it is futile to estimate the increasing value of timber for a certain purpose if at the end of the rotation that purpose has ceased to exist! Systems of management based on fixed areas, fixed prices, and fixed demands, will in many cases become outmoded. Such systems are based on estimations of future profits which few industrial concerns would venture to forecast, and are little more than theoretical exercises with only an indirect bearing on forest pratcice.

It used to be thought that a working plan was something like a railroad track. Provided the forester stopped at the annual stations to unload mature trees and pick up his quota of seedlings, he could not get off the track or go far wrong. In the future, planned management will be more like driving a car on roads without sign-posts. The right direction must be thought out afresh at every turn. Only a flexible programme will meet changing economic requirements and objects of managements, under which by-products or subsidiary species may suddenly assume more importance than the former main crop. Its working naturally calls for a greater degree of skill and a wider technical knowledge, but in no other way can a fixed investment such as a forest be made to yield its maximum return. It must produce what is profitable to-day, without impairing its ability to produce something, perhaps a very different something, which will be profitable to-morrow—*Sylva,* 1942-43.

WOOD AND WAR [1]

By CARLILE P. WINSLOW[2]

This article stresses the importance of wood as a critical material in modern war, and discusses briefly some of the important recent developments in increasing its serviceability as exemplified by the work of the Forest Products Laboratory.

In the popular mind this is a war of dive bombers and high speed armored divisions—yet to make this war of machines function requires a larger quantity and variety of forest products than has been used in any previous war. As a matter of fact, this has been recognized by the Germans for a long time. Three years ago this month, before leaving Germany, I learned that Goering had put wood second on his list of essential materials—second only to steel.

WAR'S DEMANDS ON WOOD

The list of wood items demanded by war's insatiable appetite goes on and on—wood for hangars, scaffolding, boats, wharves, bridges, pontoons, railway ties, telephone poles, mine props, antitank barriers, shoring, shipping containers, and air-raid shelters; plywood for airplanes, blackout shutters, prefabricated housing, concrete forms, ship patterns, assault boats, ship interiors, truck bodies, and army lockers; fuel for gasogense, for trucks and tractors; plup and paper for surgical dressings, boxes, cartridge wrappers, building papers, pasteboards, gas-mask filters, printing, and propaganda distribution; synthetic wood fibers, such as in rayon, artificial wool and cotton, for clothing, parachutes, and other textiles; wood cellulose for explosives, wood charcoal for gas masks and steel production; rosin for shrapnel and varnishes, turpentine for flame throwers, paint, and varnishes; cellulose acetate for photographic film, shatterproof glass, airplane dopes, lacquer, cement, and molded articles; wood flour for dynamite; wood bark for insulation, tannin, and dyestuffs; and alcohol from wood for rubber. Only recently the government has ordered that all Army truck bodies shall be built of wood to conserve steel—a use that is currently requiring approximately a million feet of hardwood a day.

The amount of lumber used for containers is almost unbelievable. The number of boxes required for the shipment of ammunition alone runs into thousands per day. It is estimated that more than 7 billion—not million—board feet of lumber will be required for containers in 1942 and a substantially greater amount in 1943.

All told our lumber needs this year (according to the War Production Board) will exceed 39 billion board feet. Actually we are estimated to be cutting only 33 billion feet. A stock pile of some 5 billion feet in the hands of manufacturers is rapidly vanishing in the face of this gap between production and consumption.

The bumper grain crop this year called for additional storage capacity which required release of lumber frozen for military purposes. In the agricultural

[1]. Address delivered at the 51st annual meeting of the International Concatenated Order of Hoo-Hoo in Milwaukee, Wis., Sept. 10, 1942.

[2]. Director, Forest Products Laboratory, Madison, Wis.

implement field there is urgent need to replace war-commandeered steel with wood if we are to continue to meet agricultural production goals. Lumber, therefore, has become one more critical material of which we do not have enough.

Eight months ago our war agencies were beginning to seek ways and means of substituting wood for steel wherever practicable, but to-day they are also frantically searching to find substitutes for wood (often in uses where wood originally replaced steel). Available materials for lumber substitutes include paper and fiber products, glass, brick, masonry, and cement. I think it is a safe prediction that before long the manufacture of additional hundreds of wooden articles in common use to-day will be sharply restricted or denied altogether.

INVESTIGATIONS AT THE FOREST PRODUCTS LABORATORY

At the Forest Products Laboratory we have been deluged by requests for information about wood, the most urgent of which have come from the Army, Navy, War Production Board, and other war agencies. Our big job to-day is to help solve the manifold wood-use problems of these same agencies and of the war industries having the job of winning this war in the factories, in the arsenals, and on the distant fighting fronts.

Long before Pearl Harbor our program had been largely swung over to war objectives, and since that day we have been on a 100 per cent. war footing. Our personnel has been increased from 170 to 450 and the needs of the Army and Navy for additional services and information may require further expansion to perhaps 600 or 700 before the end of the year. Two extra shifts have already been added and our testing machines are in intensive use from 6 a.m. until nearly midnight.

We are working in close co-operation with the war agencies and obviously are not free to disclose the methods and results of much of the work except to government and other agencies properly authorized to receive it. I can, however, outline some of the things the Forest Products Laboratory is doing which will give a perspective of trends in important developments.

TIMBER CONNECTORS AND GLUDE LAMINATED ARCHES EXTEND WAR-TIME USES OF LUMBER AND ALLEVIATE METAL SHORTAGES

Based on the Laboratory's developments of the necessary engineering data, the Timber Engineering Company associated with National Lumber Manufacturers Association has extensively developed the use of connectors, which increase the strength of bolted timber joints 4 to 5 fold. This has resulted in the use of a billion and a half board feet of timber in the efficient construction of thousands of structures all over the country including bridges, factories, hangars and shiplofts, many to serve war production. More than half of this footage has been used within the last year, as a result of which a quarter to a half-million tons of steel have been saved for direct war uses where only steel will serve.

Similarly, the Laboratory's pioneer engineering work with laminated glued arches has resulted in the commercial production of such structures by six companies and the construction of hundreds of buildings using laminated wood instead of steel.

PACKING FOR OVERSEAS WAR SHIPMENT

Cooperating with the War Department the Laboratory is extensively engaged in the development of designs and specifications for boxes and crates and for loading and packaging of ordnance materials and equipment including ammunition, tanks, guns, and other combat items for the expeditionary forces. Items must be so packed as to arrive whole, free from moisture, rust, and decay, plainly marked, readily and quickly accessible, protected against pilferage and packaged so as to conserve weight, lumber, and limited cargo space. Thousands of items are involved and in practically all cases better packages are developed, with savings of vital shipping space of from 5 to 30 per cent. Similar services are being given to Lend-Lease and other government war agencies as required.

The Laboratory is also now giving intensive educational training to 120 Ordnance packaging inspectors each month, and also similar training to Army Air Service packaging inspectors.

ACCELERATED LUMBER DRYING, TO REDUCE BOTTLE-NECKS IN DELIVERIES OF DRIED LUMBER FOR WAR USES

To offset the fact that dry-kiln capacity and the skill with which it is operated is a determining factor in planning increased lumber production for war, the Laboratory has experimentally developed accelerated seasoning methods, both by conventional kiln drying and by "chemically seasoning" and kiln drying, for drying important forest products used in war. This work has already produced the following results: drying time for thick aircraft spruce reduced without increase in degrade; drying time for walnut gunstock blanks reduced from two months or more to 50 days; drying time for Lend-Lease maple shoe-last blanks reduced from 6 months combined air and kiln drying to 45 days; birch rapidly seasoned and hardness increased by chemical treatment that may make this species a substitute for dollar-a-board-foot dogwood now regarded as the ideal wood for shuttles used in making textiles for tents, clothing, and other war supplies; spruce, maple, and birch bobbins likewise seasoned and hardened with the possibility of increasing service life and of obviating the need for metal ferrules.

PLASTIC WOOD

It was discovered that wood, especially oak, which has been soaked in a concentrated solution of urea and then dried, becomes plastic and capable of being bent, twisted, and compressed when a temperature of approximately 212° F. is reached and while still dry. The wood retains its plasticity while at or above the critical temperature, and resumes its normal hardness and rigidity when cooled, retaining its altered shape unless reheated. A modification of the above process, involving the use of ureaformaldehyde, produces a synthetic resin within the wood and under proper control results in a thermosetting material with increased hardness, similar initial plasticity, and reduced hygroscopicity and tendency to swell and shrink. This work has not yet been developed far enough for commercial use, but it has many interesting possibilities.

"IMPREG" AND "COMPREG"

The treatment of veneer with a water-soluble mix of resin-forming chemicals so as to impregnate the wood-fiber walls, and the subsequent curing of the deposited resin with heat, result in a material of high antimoisture, antishrink qualities now known as "Impreg." The presence of the uncured resin within the cell walls also makes it possible to compress and bond the veneer when heated under pressures lower than those required for untreated wood, in such a way as greatly to increase density, hardness, and resistance to moisture and shrinking and swelling—to produce a modified wood known as "Compreg." By varying the number of plies in a given "Compreg" assembly a longitudinal variation in density of the product can be produced and hard, self-glossed layers of "Compreg" can be added to uncompressed cores of "Impreg" in one operation. This product, which can be built up into thick sections and readily molded, is now in experimental production for ground-test and flight propellers, air-plane landing wheels, electrical control housings for torpedo boats, special ship decking, airplane semistructural skin surface parts, and other airplane fittings.

WOOD PLASTIC

The Laboratory has developed from sawdust or other processed wood waste a plastic filler for molding a cheap, black plastic useful in non-stressed or moderately stressed articles; also, a resin-impregnated hydrolyzed-wood sheet which can be laminated under heat and pressure to form, with double curvature if desired, a material that appears to have possibilities for use in moderately stressed parts for airplanes and gliders.

The first of these plastics, because of its light weight and high acid resistance as compared with hard rubber, appears to be destined for early use in storage battery boxes for military vehicles and naval units. The wood plastic requires up to 50 per cent. less critical war-restricted resins than do the general-purpose phenolics using wood-floor filler

PAPER-BASE PLASTIC OF HIGH STRENGTH

An improved paper base plastic equaling aluminum in tensile strength on a weight basis has recently been developed by the Laboratory and is already being used experimentally for aircraft parts including wing ribs, wing tip skins, and control surfaces.

Experimental data thus far available indicate that the product has double the tensile strength of conventional laminated paper plastics and that it can be molded to desired shapes at temperatures and pressures and on equipment now used for making plywood. It is resistant to moisture, remains extremely stable at both high and low temperatures, and is resistant to scratching and denting. The product has a smooth surface requiring no special finish, and indications are that it is not corroded by salt water and that it does not splinter, tear, or "flower" out when pierced by bullets.

Special interest attaches to the development because of the growing shortage of other materials, and its possible use in aircraft, small boats, and innumerable other applications.—*Journal of Forestry,* Vol. 40, No. 12, dated December, 1942.

INDIAN FORESTER

OCTOBER, 1943

TYPES OF CHARCOAL KILNS—II

By K. L. Budhiraja and A. C. Dey

BRICK-WALLED KILNS

Brick-walled kilns are permanent structures and the initial outlay is not meagre and, therefore, they are hardly ever found in forests where contracts are given annually, coupe by coupe, depending on the fellings. Such kilns, by preference, are set up near saw mills, distilleries and other industrial centres, where a regular supply of the raw material in the form of wood waste is available.

1. Nilgiri Type of Kiln

(*Communicated by* M. F. Bridge I.F.S., *Dist. Forest Officer, Nilgiris, Ootacamund,* 1929.)

Brief Description of the Kiln.—The billets are converted into charcoal in three permanent octagonal kilns constructed in the block. The kilns are constructed in a sheltered place in the proximity of water. The soil is sandy loam which is just the soil required for the even carbonization of wood, as this type of soil is not too porous and the admission of air is uniform and not excessive. Further a sandy loam soil is a suitable absorbent of the liquid exudations resulting from the distillation of wood.

The kilns are constructed on level ground and the floor of the kiln is natural soil well-rammed. The foundation is constructed of boulders in mud-mortar to a height of 18 inches with an equal breadth. On this foundation, a basement of bricks, laid on edge in mud-mortar of the same breadth and six inches high is constructed. The top of basement is level with the ground surface. On the basement, walls of burnt brick in mud are constructed $1\frac{1}{2}$ brick thick and 7 feet high. The breadth of each side, when measured outside is, 4 feet 6 inches, while inside it is 3 feet 6 inches. There is a rectangular draught hole at the bottom and centre of each side for the inlet of the air required for carbonization.

The roofing is formed of corrugated galvanized iron sheets supported on four iron rods, each one inch square in section. There are five square holes in the roofing, the central one being 7 inches by 7 inches and the other four smaller ones being 3 by 3 inches at right angles to the central hole.

A doorway (5 feet by $2\frac{3}{4}$ feet) is provided in each kiln and, after the kiln is packed, the doorway is closed with a corrugated galvanized-iron sheet which fits into a groove at the top of the doorway.

Manufacture of Charcoal.—The fuel used should be sufficiently dry. Billets should be three feet in length and are cut with cross-cut saws. They should be 15

inches or under in diameter. Round billets (unsplit) give better results than split ones. The outturn of charcoal is greater in the case of round unsplit billets than when split ones are burnt. The bigger a billet is the larger the proportional return, but handling very large billets by human agency is not feasible. Smaller billets are also at times a necessity to pack the fuel in the kiln as closely as possible.

Fuel has to be stacked in the kiln as closely as possible and it is best done by arranging it in three tiers—the first two vertically and the last and topmost horizontally. A kiln of the type, in vogue, holds 300 cubic feet of stacked fuel. Only billets of a uniform girth of and below two feet are to be stacked in the bottom layer, the bigger billets being used in the second and centre tier. The top layer also can be stacked with still bigger-sized billets if space permits of their being thrust in. Generally, smaller billets are used for the topmost layer. In each tier the biggest of the billets in that particular tier should be in the centre. Simultaneously with stacking the fuel for the first (bottom) layer, some easily-combustible material should be placed inside the kiln at one of the ground vents for the purpose of alighting the wood. This vent is generally the one on the windward side and next to the doorway. Unburnt billets obtained from a previous burning are best kept inside the kiln at the doorway as combustion at the door is always slow and unsteady. After the stacking is completed, the doorway is closed and rendered airtight by packing with mud, all vents at the bottom and at top (roof) being kept open.

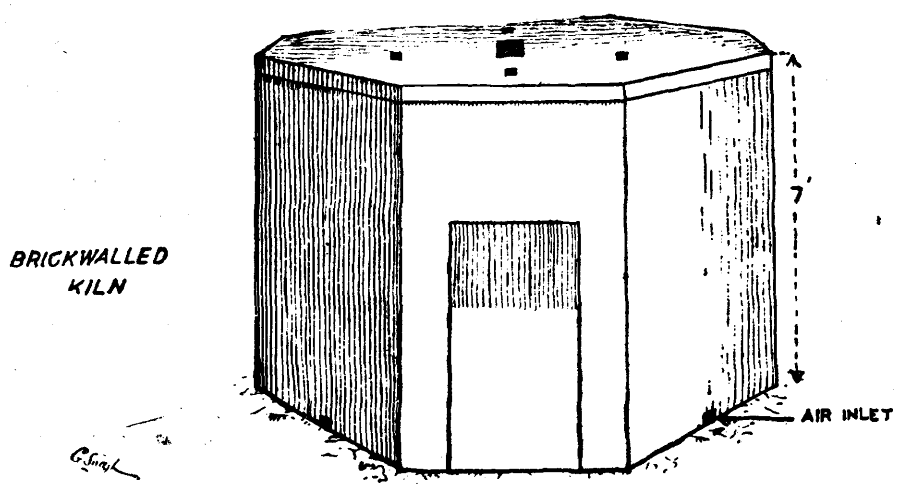
Then fire is set through the bottom vent to the easily-combustible stuff which is placed inside the kiln. When it is seen that the billets at this vent have commenced to carbonize freely, this vent and the central big vent at the top (roof) are closed by placing an iron sheeting over it and plastering it with earth so as to render it airtight. The next bottom vent is watched for flames. It takes from half to one hour's burning before it is necessary to close the first bottom vent and the centre one at the top. The fire spreads to the next vent after six to eight hours. As soon as combustion is noticed at the end of the second vent at the bottom it, as well as the side vent at the top (roof) in between this and the previously closed bottom vent, is closed and made airtight. As carbonization goes on, all seven bottom holes and the four side vents at the top are completely closed one by one in three or four days' time. For every two bottom holes one top vent only is closed. The combustion and closing of these vents mainly depend upon the nature of the wood, weather conditions, straight of the wind and, finally, supervision. A ready method of knowing that carbonization is complete at a particular part of the kiln is the issuing of a blue smoke from that particular vent.

When the burning is complete all the holes are closed and the kiln is kept airtight for two or three days for cooling. The time taken for cooling also varies in different kilns under different conditions.

After cooling the door is first opened. If burning embers are still seen inside the kiln the door is again closed and the kiln left alone for a day or two more. Attempts to put out the fire by pouring cold water—a recourse which invariably suggests itself to all—should on no account be made in the first instance. By this it does not mean that a small burning piece should not be sprinkled over by water in the course of unloading the kiln.

If sufficient care is taken, each billet can be removed as it was stacked, nicely burnt. From the kiln it goes straight into bags and to the weighing scale and ultimately to the godown. Generally, 56 lbs. or half a hundred weight is contained in a bag. Each bag, if reweighed after some days may show an increase in weight of from half to one pound. No definite data can be given for the outturn of charcoal. The outturn depends entirely upon many factors, all of which play a very important part in the correct yield. The chief thing is the fuel used. Different species may give different yields in weight and in volume. Even the weight of one lot of fuel varies greatly from other lots from the same tree.

Fig. IV



BRICK-WALLED KILN AS USED IN NILGIRIS

The average outturn of charcoal, in general, can safely be put at 21 per cent. by weight of the fuel burnt.

2. The Conical Brick Kiln

(Reprinted from the Journal of South African Forestry Association, No. 9, October, 1942, pp. 39-40—P. J. A. Loseby and C. C. Van Der Merwe)

This kiln has been designed and worked by Mr. Hunt Holley of Umkabela, Natal.

This is a kiln of very large capacity, taking up to thirty tons of wood and yielding about seven tons of charcoal per burn. Carbonization of the charge takes place in the extremely short time of 12 to 24 hours but, on account of the large cross-sectional area of the base of the kiln, cooling is so slow that the kiln can be run only three or four times per month.

A kiln with 14-inch walls was found to have a life of about seven years and it is thought that the provision of 18-inch walls will increase the life very considerably. A certain amount of skill is required in building the walls which are erected on a tilted foundation to give them correct batter. The top of the kiln is reinforced with a steel ring with projections which are let into the brickwork. An iron lid is provided and also an iron door for charging and discharging.

The kiln is packed with wood up to 15 feet in length through the door, charging of the uppermost part being completed through the top opening. The charge is ignited at the top and, as soon as the fire is strongly alight, the lid is dropped into position. The smoke now issues from the top row of openings in the wall, air being drawn in through the lower rows of openings. As soon as it is apparent from the colour of the smoke that carbonization has proceeded as far as the upper openings, these are closed down with the result that the middle row of openings now function as smoke outlets. These are closed as soon as the smoke shows indications of turning blue and the burn is run to completion with only the apertures round the base of the kiln open. These are closed one by one as the smoke becomes blue until eventually all of them are sealed. Any leaks which then become evident are carefully sealed and the kiln is left for several days to cool down.

Fig. V

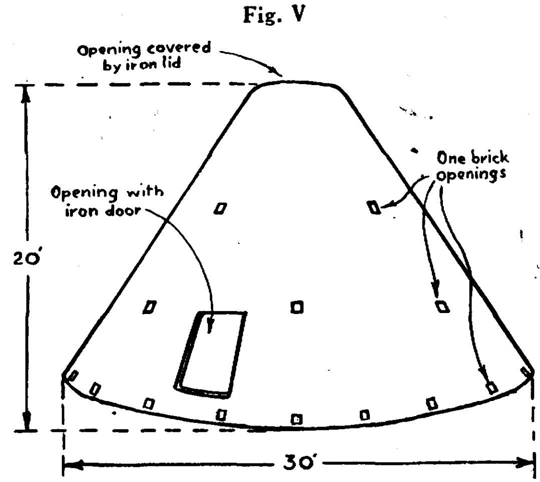


FIG. 5, CONICAL BRICK KILN.

3. Siamese Type of Kiln

(*Reprinted from the "Malayan Forester," Vol. IX, October, 1940, pp. 178—182
—E. D. Robertson*)

Another type of brick-kiln kown as the Siamese kiln was introduced in 1930 by charcoal burners who migrated from Thailand to Matang (Malaya), and is described below. Ever since the introduction of this kiln an important charcoal burning industry has developed in the Matang Mangrove reserves in Perak.

Preparation of Foundation.—The Siamese kiln can be erected anywhere in the mangrove where the soil is reasonably firm, but it is essential that the foundation be built up to at least one foot above high-water-level. A convenient site, perferably on sandy soil, is chosen alongside a canal or stream which will permit of the passage of loaded *sampans** at medium-high tide and it is then cleared by the removal of all vegetation including stumps and roots. Between the actual kiln site and the canal or river a space is left for loading and unloading *sampans* and lorries and for stacking timber and charcoal. The layout varies, but a useful arrangement is to have a space 30 feet wide, including a platform six feet wide by the waterside and, if lorries have access to the site, it is convenient to have a loading platform 12 feet wide alongside the shed.

The foundation for the kilns varies from place to place. Vertical piling may be necessary where the ground is soft, but a mattress foundation should provide adequate support on firmer ground. A mattress is formed from *bakau*† logs of 15 to 20 inches girth laid close together and packed with sand or mud. The foundation is usually about 24 feet square, the sides being three or four feet longer than the diameter of the kiln. The square is covered with logs laid parallel and close together, after which the interstices are filled with sand and it is left open to the rain for a day or two to allow the sand to settle. A thatched shed approximately 20 to 25 feet in height is then built over the site; in some cases this may be built before preparation of the foundation is begun. The shed should be large enough to cover a space about 15 feet wide between the kiln foundation and the external stacking and loading platforms, this covered area being required for the stacking of charcoal immediately after removal from the kilns and as shelter for the workers. The materials used in the construction of the shed are *bakau* poles and inferior timbers such as *mahang*‡ or *balek angin*§ for the framework, with *nipah*‖ thatch to cover the roof and walls. After the completion of the roof, a second layer of logs is laid on the foundation, the logs being at right angles to those in the first layer, and the crevices are again packed with sand, the process being repeated until the desired height is reached. Inland clay or laterite is then laid on the foundation and firmly rammed until it has been built up to a height at least one foot above high-water-level. The surface is rammed at intervals for a few days and carefully levelled. It is then ready for the construction of the kiln.

Where vertical piling is necessary, poles of the requisite length are driven in to the ground closed together until their ends are flush, the interstices are filled with sand and clay is rammed on top in the manner already described to form the floor of the kiln. In some cases, mattress foundation and vertical piling are combined,

a ring of piles being driven in round the periphery of the proposed kiln to provide a firm base for the walls.

Methods of Kiln Construction.—The material used in the construction of the kiln are ordinary housebuilder's bricks, yellow clay from inland sources (mangrove clay cannot be used owing to its salt content), river, sand and fresh water. The clay is placed in a clay-walled compartment three feet square and mixed with water to a thick creamy consistency so that impurities can be removed by hand. It is then ladled into an adjoining compartment and sieved river sand is added, the whole being thoroughly mixed until the consistency is sufficiently thick for the mixture to be used as mortar. The proportions used are approximately three parts of clay to one part of sand.

The kiln itself has a vertical circular base about 21 feet in internal diameter and approximately 3½ feet high, surmounted by a dome, the total height being approximately 12 feet. The vertical wall is 18 inches thick for the first four layers of bricks, and then 13½ inches for the upper nine layers. Five apertures approximately equidistant from each other are left in the vertical wall. Four of these apertures are small vents and the fifth is the door which gives access to the kiln when it is being filled and forms the firing aperture during the burn. The four vents are at ground level, each being a passage through the thickness of the wall, 4½ inches broad, 13½ inches high and 18 inches long, leading to a flue of 4½ inches square section built on to the outside of the vertical wall. A dome with a wall nine inches in thickness is built of a single spiral header course with a corbelled arch over the door, the arch being closed at six feet above the ground. On the side of the kiln opposite to the door two vent holes are incorporated, six to seven feet above floor level and seven feet apart, their size being such that each can be sealed by the insertion of a single brick. The curve of the dome is obtained by placing slightly more mortar between the bricks on the outside edge than on the inside, a stage of kiln construction that requires considerable skill. When the dome is complete, the external and internal surfaces are plastered with a thin coating of the mixture of clay and sand. Finally, the inside of the kiln is floored with a layer of bricks, but in some cases this flooring is not put in until one or two charges have been burnt.

A well-made kiln can be expected to last nearly ten years without requiring major repairs. Kilns are generally arranged in batteries consisting of six up to fifteen or more units in a single or double row, the distance between each kiln and its neighbour being only two or three feet. This makes for economy in labour and supervision costs.

Burning.—The charges consist of round billets of mangrove wood usually about five feet long and of varying girth, those with a girth of 16 to 20 inches being said to make the best charcoal. Exceptionally heavy logs may be cut in three-foot lengths; but this is unusual and of doubtful benefit as it involves stacking the short lengths in the kiln one on top of another and such lengths are awkward to handle. The majority of the billets have the bark removed before they are transported to the kilns: the smaller sizes less than 12 inches in girth are not barked.

The kiln is filled by vertical close packing to a height of five or six feet, the lower ends being supported on single bricks. This ensures complete carbonization and is contrary to former practice, when the billets were not so supported and the proportion of incompletely carbonized wood was excessive. Only the base of the kiln is packed, leaving the dome empty. Inferior wood is stacked near the door, where a certain amount of loss from complete combustion is unavoidable. When the kiln is full, the door is partially built up with a single stretcher course, care being taken to break joint. An aperture for firing is left at the bottom, this being 18 inches wide at the base, 24 inches in height and six inches wide at the top, with sides that are vertical for the lower 12 inches and then slope to the apex. The bricked up part of the door is plastered over with clay and sand mixture.

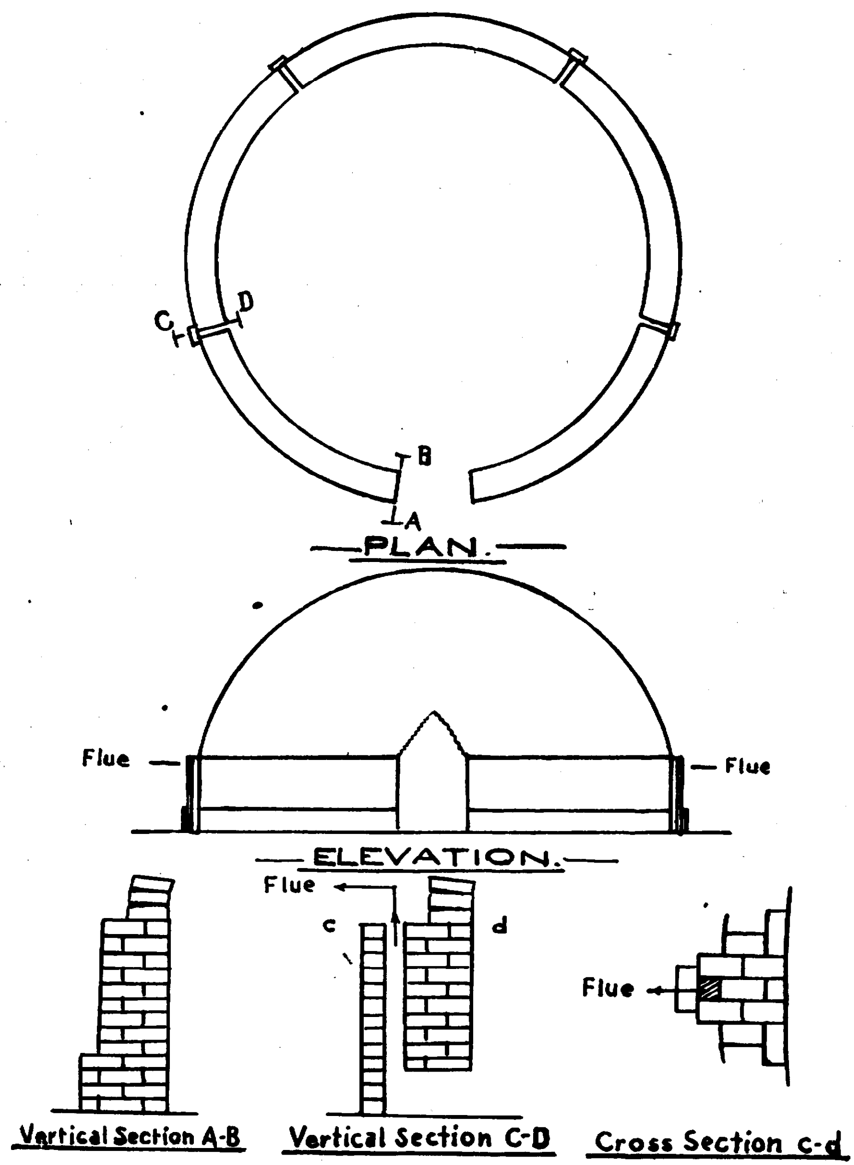
A fire is lit in the aperture, ordinary *bakau* firewood being used. After it has been burning for ten days, the two vents in the dome of the kiln, opposite the door, are closed. For the next few days, the fire is gradually reduced until, approximately five days later, the burning firewood is all removed and the aperture is bricked-up until a hole only nine inches square is left open. It seems that the fire is removed when the temperature inside the kiln reaches combustion point; the charcoal burner watches the four vents in the vertical wall of the kiln, and when dense hot greyish-brown smoke begins to pour out of the vents and smoke and flames blow back out of the firing aperture, it is time to remove the fire. Another test is to place a sliver of wood across one of the vents; if this chars rapidly it is an indication that the fire can shortly be extinguished. After the fire has been removed, the kiln is left with the vents and the small frontal aperture open for approximately ten days; the smoke from the vents then becomes scarcely visibile and ceases to have the hot spicy odour so far associated with it. When this change takes place, all the apertures are sealed and the burn is left for about a weak to complete itself and for the charge to cool. At the end of this period the door is opened and the charcoal removed. The kiln is emptied and re-filled with a fresh charge as quickly as possible in order to avoid lowering of the inside temperature unduly before the start of the next burn. The time taken to carbonize one charge is about thirty-two days.

The charcoal produced is of good quality and the percentage of imperfectly-carbonized material, known as *"kepala arang,"* is low. In a good burn, no *kepala arang* should be left, but control may sometimes be faulty, resulting in incomplete carbonization of a few inches at the base of each log. The amount of *bakau* wood required to charge a kiln is 450 to 550 *pikuls*¶ and the quantity of charcoal produced from the burning of one charge is between 140 and 160 *pikuls*, while approximately 35 *pikuls* of firewood are required for firing each charge. The average conversion rate for *bakau* is 1 *pikul* of charcoal to 3.7 *pikuls* of wood, including the quantity used in firing. This figure has been calculated from a wide range of measurements.

The technique of burning is highly specialized and requires the employment of skilled charcoal-burners. In districts where the method is unknown it would be advisable to engage at least one experienced burner to start the industry and train the local labour.

Fig. VI

CHARCOAL KILN-SIAMESE TYPE.



4. A Charcoal Kiln of Brick Construction

On account of the scarcity of steel, a charcoal kiln of brick construction, using steel only for the lid, has been based in design on the Forest Products Research Laboratory, Princes Risborough, Aylesbury, Bucks type of portable kiln (*vide* Forest Products Research Leaflet No. 24, "Further Notes on the Manufacture of Charcoal in Portable Kilns," July, 1942). The kiln is described by P. Harris (HARRIS, P., 1942. *Empire Forestry Journal, 21* (2)).

* *Sampan* = a small boat.
† *Bakau* = *Rhizophora* spp., *Bruguiera* spp. and *Illicium* spp.
‡ *Mahang* = *Macaranga* spp., and *Mallotus* spp.
§ *Balek angin* = *Commersonia* spp., *Macearanga* spp., and *Mallotus* spp.
|| *Nipah* = *Nipa fruticans.*
¶ 1 *pikul* = 133⅓ lbs. 1 ton = 16·8 *pikuls.*

TYPES OF CHARCOAL KILNS—III

METAL KILN

Summary.—A portable metal kiln, "Frikiln," designed at the Forest Research Institute, Dehra Dun, to suit Indian conditions, has been described. Details of its construction and working, along with its relative advantages, are given.

1. Charcoal-making in pits and brick-walled kilns cannot be carried out under all circumstances and conditions. For instance, in places where wood is scattered over a wide area, it is cheaper to have a portable kiln which could be conveniently shifted from place to place rather than to bring the wood from great distances to the kiln. Similarly charcoal burning is not permitted in the forests during the hot, dry weather on account of fire hazard and it is impossible to manufacture charcoal during the Monsoon by the usual indigenous methods. In order to suit such circumstances, various types of metal kilns have been designed in different countries, *viz.*, France, England, Germany and South Africa. Fundamentally, all metal kilns are similar in essentials. A well-designed metal kiln possesses the following distinct advantages over other types: (*a*) Quick carbonization, (*b*) Quick cooling, (*c*) Portability, Freedom from leaks, (*e*) It can be used in hills or plains, (*f*) It can be used throughout the year, (*g*) No danger of fire hazards, (*h*) The burning of the kiln is practically automatic, and (*i*) The outturn and quality of the charcoal are superior. The large metal kilns are, however, expensive in their initial cost; nevertheless, the need of such a kiln has long been felt. A kiln known as "Frikiln" has been designed at the Forest Research Institute, Dehra Dun, incorporating all such features which are essential under Indian conditions. Its component parts are made of standard materials (mild steel) readily available in normal times in Indian markets. Its heaviest component weighs 62 lbs. and can be easily carried by a coolie even on the hills. The design is simple and can be constructed by local blacksmiths. Its full description has already appeared in *Indian Forester* (RAMASWAMI, S., 1935. F.R.I. portable charcoal kiln. *Indian Forester,* **61** : 19—22).

(*Concluded.*)

FIREPLACES

BY J. L. HARRISON, I.F.S.

Timber Development Officer, Forest Research Institute, Dehra Dun.

To build a fireplace in forest buildings, which fireplace would draw right away, has been very much of a gamble in the past. To a certain extent standard designs were followed but to build a fireplace which did not smoke and which gave out reasonable heat into the room for the amount of fuel consumed was, in many cases, a matter of luck. This state of affairs was not confined to the forest department but extended to the P. W. department and to India generally. Moreover, in England the older designs of fireplace, while they draw reasonably well, waste about 70 per cent. of the heat which in place of going into the chimney, goes up the chimney.

In a fireplace, the upward draught is caused by the heated air in the flue rising and being replaced by cold air from the room. This being so, obviously the smaller the cross-sectional area of the flue and the greater its length, the more readily the air in the flue would heat up and, with the greater length, the faster the hot air would rise. In England, various manufacturers realised the necessity of improving fireplace design both for improved draught as well as to obtain the maximum heating in the room for the amount of fuel consumed. Various designs were produced but many of these grates were sold as a unit to be built in and were in the nature of trade secrets with no publication of details of construction or dimensions. In my experience, American firms are more ready to publish data found as a result of experiment and experience. The Common Brick Manufacturers' Association of America investigated this question of fireplace design and published the results of their researches. The fireplace designs I have drawn out and much of the data I give below are based on the publications of that association.

I had previously been content to follow local fireplace designs and it was not until coming to Dehra Dun and having to lecture at the colleges, that I made a study of the design and construction of a really satisfactory fireplace. While the general principles in design are few, simple and quite logical, these are not always understood and if understood, not followed. The requirements of an efficient fireplace are:

(*a*) To get initial and, later, steady combustion of the fuel used.

(*b*) To get an initial draught and to ensure a continuous draught up the flue so that little or no smoke is sent out into the room.

(*c*) To reflect the maximum amount of heat from the fireplace into the room.

To obtain the above results it is necessary—

(*a*) To have a proper design of the actual combustion chamber.

(*b*) To settle the correct size of the fireplace opening and to make the cross sectional area of the flue proportional to the fireplace opening. (Only in America's publications have I seen it laid down that there must be a definite relation between the area of the fireplace opening and the cross-sectional area of the flue and yet that this should be so is very logical.)

(*c*) To arrange a proper design of smoke chamber between the throat of the fireplace and the flue itself. The introduction of a "smoke shelf" is a very important feature of successful fireplace design.

Location of Fireplace.—It is difficult to lay down any hard and fast rules as to where a fireplace is best located in any room. If the maximum radiation is required, the fireplace should be built in an inside wall. It should not be built near a door nor where people sitting in front of the fireplace would be subject to any cross draughts. In settling where the fireplace is to be; all that can be done is to follow these main considerations of getting the maximum radiation and of giving the maximum comfort to the occupants of the room.

Size of fireplace and fireplace opening.—The fireplace opening should be proportional to the size of the room to be heated. For a room of around 300 square feet

of floor space a fireplace opening of 30 by 36 inches is considered sufficient. There is usually a minimum width of 30 inches and the height from the hearth to the bottom of the throat may be from 24 inches (for a small room) up to 36 inches. For larger rooms the sizes would be increased but few rooms in forest buildings have a floor space greater than 300 square feet. The depth of the fireplace is governed by the thickness of the wall or by the extent to which the jambs can project into the room. A shallow fireplace throws more heat out into the room and a deep fireplace not only gives no advantages but often results in a great waste of heat. The depth can be from 16 to 24 inches.

Combustion chamber of the fireplace.—To obtain the maximum radiation of the heat into the room, the sides should slope inwards towards the back and, higher up, the sides should slope towards the throat although the latter condition is not so important as the sloping towards the back. Moreover, the back should lean forward. Experience and research have shewn that the best results are obtained if the inclination of the sides towards the back is approximately five inches in every 12 inches. The back should start sloping at a point a little below half way between the hearth and the throat and the angle of slope of the back should be three inches horizontal to every five inches vertical. The maximum angle of slope should not exceed 30 degrees. The plan, elevation and cross-section of the fireplace design as shown in *Plate* 17, Fig. I, will illustrate these points of design.

Throat.—The upper part of the sides and the back, slope up to form what is called the "throat," the throat being the opening into the smoke chamber. The top of the fireplace opening should be from four to eight inches below the throat and the greater depth is better. In the drawings of the firplace in *Plate* 17, Fig. I, a depth of about nine inches has been given. A metal damper is often fitted, in the throat opening and in the designs of fireplace in *Plate* 17, a damper is shown fitted. A "damper" in its simplest form is a metal plate hinged in a fitting and the plate can be completely closed, left wide open or opened to a varying degree. When wide open, the damper allows full draught and when the damper is partly closed the draught is shut down to a corresponding extent. A damper is very useful for controlling the draught, especially where coal is the fuel being consumed. However, unless dampers could be purchased, all ready-made from some firm, there might be difficulty in constructing and fitting these in fireplaces in forest buildings.

Smoke Chamber.—Between the "throat" and the flue comes the smoke-chamber. As already noted, this smoke-chamber, with its smoke shelf, is an extremely important feature in the fireplace design. A fireplace sending smoke into the room causes a lot of discomfort and the trouble is due to down draughts in the flue. With the hot air and gases tending to be thrown towards the front of the flue, down draughts will tend to come down the back of the flue. The introduction at the bottom and back of the smoke chamber of a "smoke shelf" deflects these cold currents up again into the ascending currents of smoke, gases and hot air. This smoke shelf is the result of research and experiment and is not only logically very sound but gives good results in practice. The fireplaces as shown in *Plate* 17, and *Plate* 18, Fig. I, have all been designed with a smoke shelf.

Flue.—The flue starts from the top of the smoke chamber and from the middle of the top. Even if the flue cannot be continued straight up, it should commence

from the middle of the smoke chamber and not from either side. To reduce friction, the inside of the flue should be as smooth as possible and a lining is given either by fitting lengths of fireclay flue lining or by pargeting with mortar. The fireclay flue linings are made to various standard sections and can be obtained ready-made and built into the flue. Forest buildings are for the most part some distance from towns or even railway communications and seldom will it be possible to obtain fireclay flue linings. In most cases the lining will be given by plastering. With the extremes of temperature in a flue, there is expansion and contraction, with a consequent tendency for the plaster to crack and fall down. Lime plaster does not give good results and the plastering should be done with good quality cement plaster, with the surface well smoothed. Plastering or rendering the flue with cement plaster is known as "parging" or pargeting. Not only does the flue lining give a smooth passage to the gases and prevent soot collecting but the lining seals up any defective joints in the walls of the flue. An alternative to a mortar made from a good quality cement is a mortar made up of one part of lime and three parts of cowdung.

Dimensions.—It has already been noted that, to get the best results as regards draught and combustion, there should be a definite ratio between the cross-sectional area of the flue and the area of the fireplace opening. In England the law used to lay down that the flue should be 14 inches by 9 inches or, in the case of circular flues, of 12-inch diameter. Nowadays a flue 9 inches by 9 inches is generally the standard dimension for a rectangular flue and a circular flue is of 10-inch diameter. This cross-sectional area is irrespective of the size of the fireplace opening. As previously stated, fireclay flue linings are made in standard sizes but in forest buildings the flues in most cases would be parged and the dimensions could be settled in proportion to the fireplace opening decided upon. The Brick Manufacturers' Association of America lay down that the cross-sectional area of the flue should be from one-tenth to one-twelfth of the area of the fireplace opening. Where the chimney was high and there was a long flue, the lesser cross-sectional area would be sufficient but for most forest buildings the larger proportion, that is, one-tenth, should be allowed for.

In the foregoing rule, the cross-sectional area to be allowed is the effective cross-sectional area. While in the case of flues of circular cross-section, the full area can be considered as effective, the effective area of a flue of rectangular cross-section is somewhat less than the actual area. The table as given below is based on the data given by the Brick Manufacturers' Association of America and gives some fireplace openings suitable for forest buildings, with equivalent suitable flue-effective cross-sectional areas for flues of both rectangular and circular cross-sections:

FIREPLACE DIMENSIONS			CROSS-SECTIONAL AREA OF FLUE.			
Width Inches.	Height Inches.	Depth Inches.	Square or Rectanguar Inches.	Effective Area Square Inches.	Circular Diameter Inches.	Effective Area Square Inches.
18	21	14	9 × 6	32	6	25
24	28	18	9 × 9	55	10	78
28	28	18—20	9 × 13	70	10	78
30	30	18—24	9 × 13	70	12	113

Fig. I

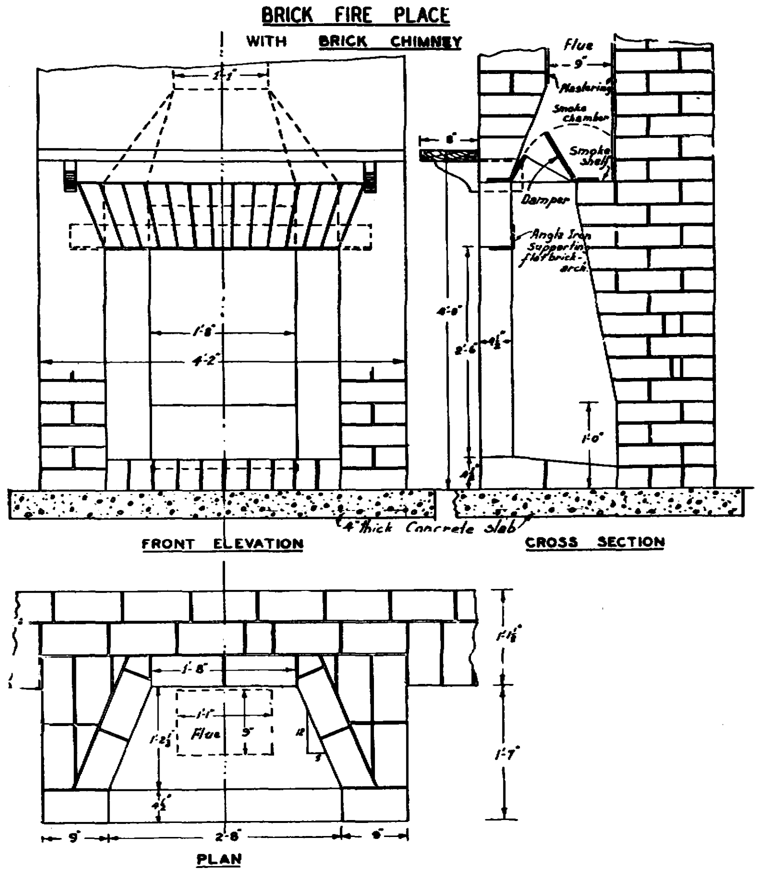

BRICK FIRE PLACE
WITH BRICK CHIMNEY
Flue
Flashing
Smoke chamber
Smoke shelf
Damper
Angle Iron Supporting flat brick-arch
4" thick Concrete slab
FRONT ELEVATION
CROSS SECTION
Flue
PLAN

Fig. II

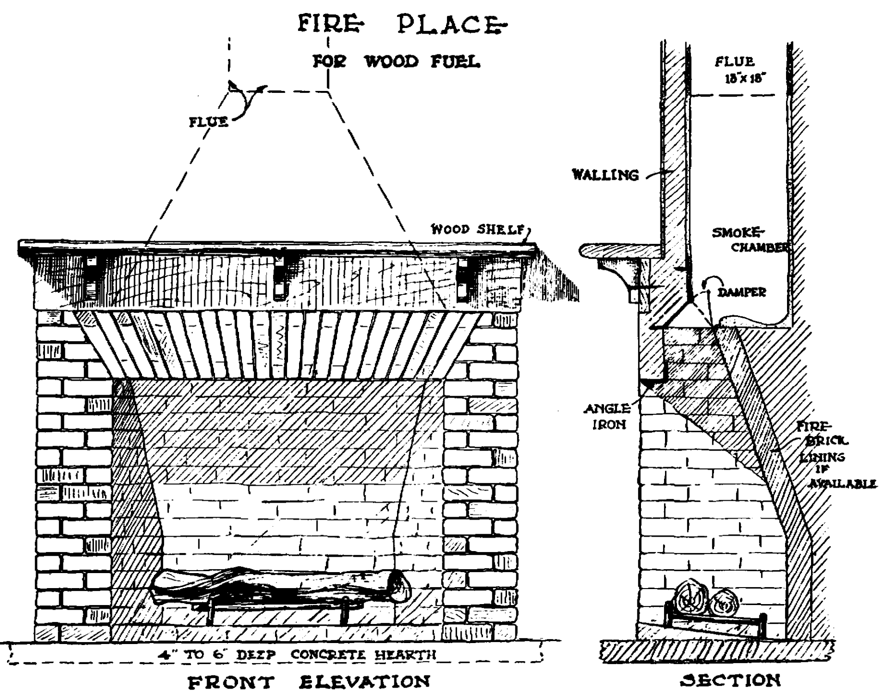

FIRE PLACE
FOR WOOD FUEL
FLUE
WOOD SHELF
4" TO 6" DEEP CONCRETE HEARTH
FRONT ELEVATION
FLUE
18"x18"
WALLING
SMOKE-CHAMBER
DAMPER
ANGLE IRON
FIRE-BRICK LINING IF AVAILABLE
SECTION

Fig. II

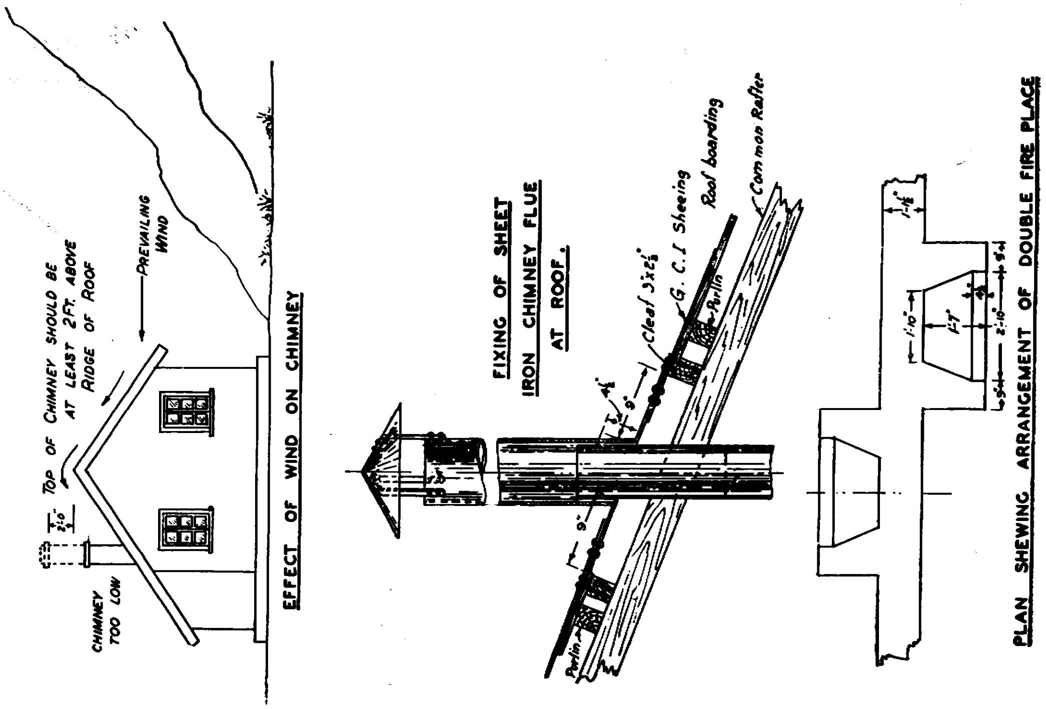
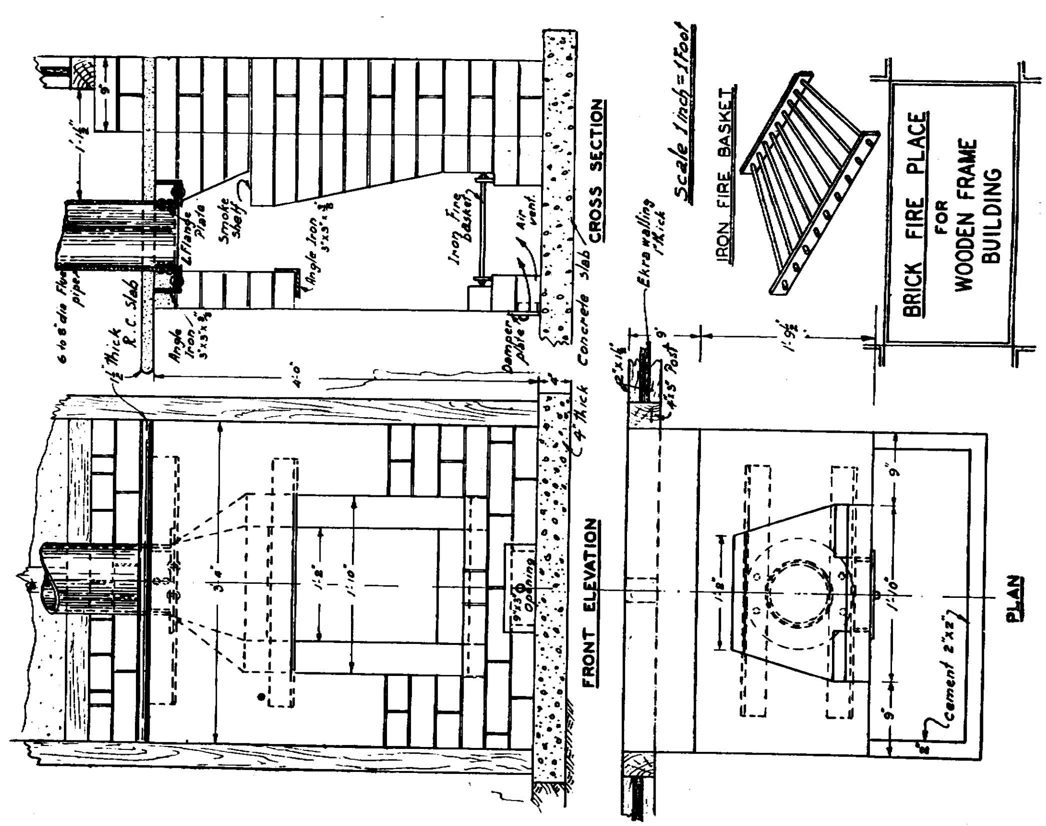

TOP OF CHIMNEY SHOULD BE AT LEAST 2FT. ABOVE RIDGE OF ROOF
PREVAILING WIND
CHIMNEY TOO LOW
EFFECT OF WIND ON CHIMNEY
FIXING OF SHEET IRON CHIMNEY FLUE AT ROOF.
G. C. I Sheeing
Roof boarding
Common Rafter
Purlin
PLAN SHEWING ARRANGEMENT OF DOUBLE FIRE PLACE

Fig. I


FRONT ELEVATION
CROSS SECTION
R. C. Slab
Smoke shelf
Iron fire basket
Air vent
Damper plate
Concrete slab
Scale 1 inch = 1 foot
IRON FIRE BASKET
PLAN
BRICK FIRE PLACE FOR WOODEN FRAME BUILDING

For effective draught and combustion, there should be a separate flue for each fireplace and the flue should be taken to the top of the chimney. There should be sufficient walling between the flues to make such smokeproof.

Chimney.—In the consruction of any chimney, care has to be taken to ensure that the top of the chimney is at least two feet above the highest point of the adjoining ridge. It is better to have the top of the chimney three feet above the ridge line. Unless this extra height is allowed, there will be a down draught caused by the wind making eddies on the roof and there will be a tendency for the fireplace to smoke into the room. The drawing on *Plate* 18, Fig II, will illustrate this point.

Many chimneys are left open at the top but, if the top is covered with a slab of stone or concrete, sufficient side openings must be given to allow the smoke ready escape. Each side opening of the chimney or, if there is more than one opening on any side, the total area of the openings on any one side, should be at least equal to and preferably greater than the total flue area or areas. Thus in whichever direction the wind may be blowing, the smoke can escape. Inspection of existing forest buildings will emphasise that in most cases the side openings are much too small.

The side openings are better to be high and narrrow rather than short and wide.

Arch of Fireplace.—To support the brickwork above the fireplace opening in front, some fireplaces have an elliptical arch. Unless there are competent bricklayers available, such an arch is not easy to construct and, so far as appearance is concerned, a flat arch looks equally well. The soundest construction is to build an angle iron into the brickwork or stonework. This angle iron gives the necessary support and on it the brickwork can be built up, either in the form of a flat arch or, in the case of small fireplaces, in ordinary bond. An angle iron has been built-in in the three fireplace designs as shewn in *Plate* 17 and *Plate* 18, Fig. I.

Design for fire prevention.—At the hearth there should always be a stone or concrete slab for the back hearth as well as the front hearth and such layer should extend in front of and to either side of the fireplace opening. In the case of wooden floors, the hearthstone is supported either by a trimmer arch of brickwork, by a steel beam or by a reinforced concrete slab. This construction in the flooring I shall not deal with here as it is standard practice. What I would remark on, however, is the fact that in many forest buildings, the hearthstone does not extend anything like far enough in front and there is constant trouble due to burning coal or wood falling from the grate out on to a wooden floor.

In some of the old-type forest buildings wooden beams were built in, projecting into a flue or with the ends almost exposed near a flue. An accumulation of soot or a huge fire set the beams alight. Such construction is hardly likely nowadays. For safeguard against fire, a sufficient thickness of wall and lining should be allowed for between the fireplace or flue and any wooden beams or other woodwork. With a flue lining of fireclay or cement mortar, the wall around the flue can be kept down to $4\frac{1}{2}$ inches. However, with such a small thickness of wall, a layer about two inches thick, of some fireproofing material, could be given between the wall and adjoining woodwork. With any doubts of the efficiency of the flue lining, it would be better to give a nine-inch wall. Between each flue at least $4\frac{1}{2}$ inches of brickwork should be allowed.

Wooden-framed buildings.—Many forest buildings are now being built of wood framing. With such a type of building, the fireplace can be either of brickwork with the flue and chimney also of brickwork or the fireplace can be of brickwork and the flue and chimney consist of a metal pipe. The fireplace in *Plate* 18, Fig. I has been designed for a wooden-frame building. The flue-pipe would have a diameter of at least 6 inches and preferably 8 inches. It will be noted that the flue-pipe has been kept well away from the wood framing of the wall. In the drawing one foot 1½ inches has been allowed and the distance should be at least 12 inches for safety. From the top of the fireplace up to the ceiling or roof the flue-pipe can either be left uncovered (giving extra heat in the room) or can have a framing built around it for better appearance. Where the flue-pipe passes through the ceiling and roof it must be kept well away from any wooden members. It would have to be supported at intervals by iron straps. About 9 inches should be allowed between the flue-pipe and any woodwork. At the ceiling and roof, the pipe should be surrounded by some fire-resistant plate, either of metal or some material such as asbestos, such plate being at least 22 inches square. The drawing on *Plate* 18 Fig. II, shews a type of construction for fixing a sheet-iron flue where it passes through the roof. The flue-pipe can be left open at top or, if considered necessary, a cowl could be fitted on top as shown in the drawing.

Roof covering.—Where the roof covering is of thatch, shingles or any such inflammable material, it is better to fit wire mesh gauze on the chimney openings where wood fuel is being burnt. With coal fuel there is less danger from sparks setting the roof alight. The wire gauze should have a mesh not greater than 1/4 inch. The fitting of wire gauze tends to reduce the draught and, where wire gauze was to be fitted, the side openings would require to be somewhat larger.

Arrangements of two fireplaces.—Where fireplaces have to be built in adjoining rooms, the fireplaces can be arranged either (*a*) back-to-back or (*b*) side-by-side or interlacing. With the fireplaces back-to-back there is more projection of the fireplace into the room. A thickness of 9 inches is allowed between the backs. Where it is desired not to have much projection into the room, the two fireplaces can be built interlacing as shewn in the bottom drawing of *Plate* 18, Fig. II.

There is a third arrangement of fireplaces, known as the diagonal method. This is used for small rooms where, for convenience's sake, the fireplace is fitted in a corner of the room. With four rooms meeting at a corner there could be a group of four fireplaces.

While in the latter part of this article I have touched on fireplace construction generally, the main purpose of this article was to bring out the necessity of, in fireplace design, considering:

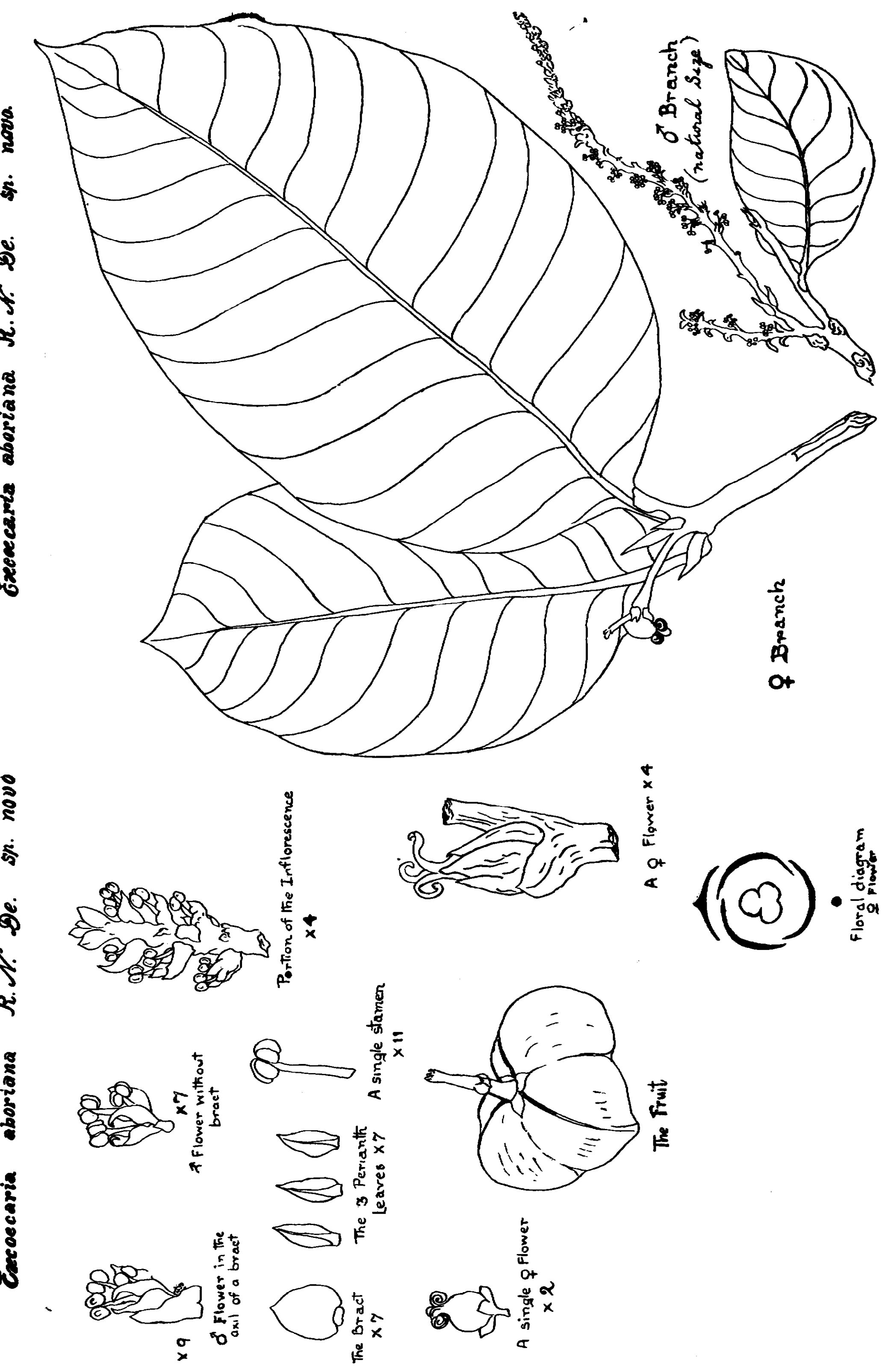
(*a*) The correct size of the fireplace opening for the floor space of room concerned;

(*b*) The cross-sectional area of the flue in proportion to the fireplace opening;

(*c*) The correct design of the combustion chamber or grate;

(*d*) The construction of a smoke shelf; and

(*e*) The allowance of sufficient side openings in the chimney to ensure a good draught.



Excoecaria aboriana R. N. De. sp. novo
♂ Branch (natural Size)
♀ Branch
Excoecaria aboriana R. N. De. sp. novo
Portion of the Inflorescence x4
x7 ♂ Flower without bract
x9 ♂ Flower in the axil of a bract
The Bract x7
The 3 Perianth Leaves x7
A single stamen x11
The Fruit
A single ♀ Flower x2
A ♀ Flower x4
Floral diagram ♀ Flower

These notes as regards design were first written some four years back and data and designs of fireplace construction were supplied to some of the provinces. Fire-places on these new lines have been built in forest buildings in Bengal and the United Provinces and given very satisfactory results. Recently the fireplace in the sitting room of the bungalow of the Inspector-General of Forests at Dehra Dun was rebuilt, incorporating the new ideas as detailed, and gives every indication of showing a very marked improvement both as regards absence of smoke in the room and much better radiation over the design of fireplace as originally built.

EXCOECARIA ABORIANA R. N. DE SP. NOVO.

By R. N. De, I.F.S.

(*Conservator of Forests, Assam*)

A small or medium-sized evergreen tree; juice milky.

Leaves opposite, coriaceous, sometimes fleshy, glabrous, broadly elliptic, 13—33 cm. by 5—16.5 cm.; base acute or obtuse; margin entire, slightly curved inwards; apex short acuminate; veins very prominent, 13—16 pairs; petiole channelled; 5—2 cm. long.

Inflorescence axillary or terminal. Flowers unisexual, minute. Male flowers in spikes, bracteate, one flower in each bract; bracts pubescent outside, orbicular, pointed above; perianth members 3, sometimes 2, elliptic lanceolate, pubescent outside, apex pointed, stamens usually 3, 2 mm. long; anthers 2-celled, extrorse, dehiscing by a suture on the outer margin, globose, glabrous. Female flowers, solitary, axillary, perianth members 3; style thick, short, stigma three-partite, long, recurved. Ovary 3-celled; fruit, a three celled capsule, triangular globose with 3 prominent ridges along sutures, 6 cm. × 3 cm.; seed one in each cell, 1.5 cm. in diam. testa hard.

Flower May-June; Fruit August-September.

Differs from *E. oppositifolia* in having much larger and broadly elliptic leaves, longer petiole, longer spikes with densely crowded flowers, and perianth not toothed. The fruit is also much larger than that of *E. oppositifolia*.

E. oppositifoliae similis sed ab ea foliis multo majoribus late ellipticisque, petiolo longiore, spicis longioribus floribus densis, sapalis haud dentatis, fructu majore differt.

The species could not be matched either at Kew or at Sibpur. I am grateful to Dr. S. K. Mukherjee, curator of the herbarium, for much help while working at Sibpur and Prof. Sally Meyer of the Bethune College, Calcutta, for drawing the diagrams and correcting the draft (*vide* Plate 19).

I have named the tree after the Abor tribe of the Sadiya Frontier Tract in whose country the species is found. Type sheets have been kept in the forest herbarium at Shillong.

NOTE ON SOIL CONSERVATION DEMONSTRATION PLOT AT KOT ZENDI, FATEHJANG RANGE, ATTOCK SOIL CONSERVATION DIVISION

BY MAULVI BASHIR AHMAD, P.F.S.

INTRODUCTION.—The demonstration plot was started in 1940 in order to show to the villagers how the cultivated lands should be terraced and embanked, culturable waste lands reclaimed and run-off controlled.

SITUATION.—Kot Zendi village is situated at an elvation of about 1,364 feet in the plateau between the Kherimar hills in the north and Kalachitta hills in the south. This plateau is cut up by deep ravines which drain into the Nandna *nalla*. There is a fairly large proportion of flat or gently sloping land which is cultivated. The ravines are narrow and deep (up to 50 feet) at the lower end but the upper drainage channels are shallow and fan out into the cultivated fields. The erosion at the top of the catchment areas of the different ravines is unnoticed by the local cultivator but the depth of the ravines at the lower end points forcibly to total erosion which is taking place. The village site of Kot Zendi is on the watershed of two ravines and the lands drain on the east and on the west into two separate channels. The plot selected drains mostly into the western ravine.

SOIL AND CLIMATE.—Soil is clayey loam overlying soft sandstone which is exposed in the ravine and its steeply sloping sides. There are *kankar* layers at places. Rainfall is about 18 inches unevenly distributed. There are one or two heavy showers in the monsoon but monsoon rains in Attock district are uncertain and irregular. The winter rains are fairly regular. From the erosion viewpoint the monsoon rains cause more damage as they follow the hot dry weather when the soil is in a desiccated condition and there is little vegetation cover.

OWNERSHIP.—The village of Kot Zendi was owned by two proprietors, Sardar Karam Khan and Sardar Khuda Dad Khan of Dharek, an adjoining village. On their death the ownership passed to their minor sons and the estate came under the management of the court of wards.

AREA OF THE PLOT.—Details of the area taken up in 1940 are given below:

Cultivated	...	...	380 acres.
Culturable waste land	...	...	44 „
Unculturable waste land	...	...	44 „
	Total	...	468 „

In 1942 additional area of about 200 acres draining into the ravines on the east was added for levelling and terracing.

TERRACING AND EMBANKING (WATTBANDI).—Area terraced and embanked is 467 acres. The work was done by the villagers themselves without cost to government. The operation is well understood locally in the district and is done after ploughing up the fields by means of a scoop (*karah*) yoked to bullocks. About 23 acres were reclaimed out of broken ravine ground on *mangalis* at a cost of Rs. 100. There is a local custom of mutual help in work of this sort on land and quite a large number of men, bullocks and *karahs* are collected to deal with an area in a short time (as the rains are irregular and this work can only be done when the soil is in a suitable condition

of moisture). Such collections are called *mangalis* which literally means "requested help." Such *mangalis* are often accompanied by the village band consisting of old trumpets (reminiscent in shape of those used in Tibetan Lama dances), *nafiris* (an instrument half like a flute and half like a clarionet), and drums. With the band playing there is a great hustle in the working of all concerned. The *mangalis* are fed by the man on whose land the work is done. No other payment is made.

CLOSURE.—Towards the south-western end of the plot the main ravine gets deeper. Sixty acres unculturable area here was closed in winter 1941-42 to grazing and browsing without any government notification. The response during the first rains (1942) was most striking. Natural *phulai* and *shisham* which were growing on the steep banks and were kept down by browsers shot up into foliage and, in October the area was full of grass up to five feet high and shrubs and trees were giving a very pleasing look to the area. The following sowing and planting work was done in this area in 1941-42 and 1942-43—sowings being done on trenches!

1941-42

Sowing done ... 12 seers *Prosopis juliflora*, 5 seers of *phulai* seed.

1942-43

Sowing done ... 100 seers *sanatha* seed, 10 seers *phulai* seed.
Planting done ... 77 mulberry cuttings, 50 *shisham* and 23 cuttings of *Parkinsonia* were planted.

Germination of all species was good but *sanatha* seedings were destroyed by hoppers and *phulai* and *prosopis* only survived.

BUNDS AND ESCAPES.—In 1941-42 a pucca bund, brick in lime mortar and cement pointed, 40 feet long, 17 1/4 feet high and 10 feet wide at bottom and five feet at top, was made in the main ravine. There was a 9-inch cement concrete foundation. The cost was Rs. 2,654. It is a very solid structure and the idea was to store water, of which there is shortage, for the use of men as well as cattle. In the monsoon of 1942 the soft sandstone sides of the ravines yielded to the pressure of water which at first overflowed the *bund*. Silt was deposited to a depth of eight feet behind the bund. In 1942-43 two wing walls of brick masonry were added at a cost of Rs. 240 and the functioning of the *bund* will be watched in the rains of 1943. The ravine in the upper parts is shallow and is cultivated. There are earth *bunds* at intervals and storm water is let out by channels cut in the banks which are of clay. These channels form new ravines in a few years. Two dry-stone "escapes" were, therefore, built at a cost of Rs. 224 on the two bigger *bunds* in 1942-43. As earth *bunds* are very common in the district, the evolution of an efficient "escape" built of locally available and cheap materials will be a great boon for the villagers. In some places the richer landlords make expensive sluice gates for this purpose but for general soil conservation work something cheaper is required which would be within the means of the poorest cultivator.

Note by Sir Harold Glover, Chief Conservator of Forests, Punjab.

The work is typical of what we are trying to do in the eroded cultivated uplands of the Rawalpindi Civil Division, and it is very pleasing to learn that the work at Kot-Zandi which had not even started when I saw the estate three years ago has already been completed. This is due in the first place to the interest taken by the revenue officers—particularly Mr. H. J. B. Taylor and Mr. A. B. Williams, Deputy Commissioners; secondly to the energy and hard manual labour of the zamindars; and lastly to the careful planning, supervision and encouragement of the Attock Soil Conservation staff.

PARABOLOID CHARCOAL KILN WITH DRY EARTH COVERING

BY G. C. DASH

(Assistant Conservator of Forests, Orissa)

In 1941, when it became apparent that there would be a considerable demand for charcoal for producer-gas plants on motor vehicles, the Conservator of Forests, Orissa, ordered experiments to be carried out in Angul Division to ascertain whether the method of manufacture which had been standardised in Sambalpur Division in 1922-23, during large-scale departmental supplies for shellac factories, would be suitable for the purpose now required.

Before describing the experiment and its results I would like to mention that the pit method described in Mr. Chaturvedi's article in the *Indian Forester* for February, 1943, was used in Angul Division but was found unsatisfactory for large-scale operations and has been abandoned in favour of paraboloid kilns with dry earth covering. The pit method produced satisfactory charcoal but as the sequence of fellings progressed the alternatives had to be faced of either constructing fresh pits or transporting billets from an increasing distance. Either alternative meant additional labour and increased cost. Mr. Chaturvedi states that an advantage of the pit kiln is that it makes charcoal in four days against a longer time for the ordinary paraboloid kiln (with a mud-plaster covering). But the paraboloid kiln now in use in Angul Division makes charcoal in two to three days (depending on the dryness of the billets used).

For the experiment two types of paraboloid kiln were burnt and we have termed them (*i*) *wet-type,* because with a mud-plaster covering water is essential, and (*ii*) *dry-type,* which has a dry-earth covering, no water being required. The kilns were constructed according to information in a report sent by the Divisional Forest Officer, Sambalpur, to the Forest Economist, Dehra Dun, in 1925. Briefly, the details of construction given in that report are that billets of a uniform length of two feet are stacked in three layers round a central flue of about one foot diameter and six feet high. The diameter of the base of the parabola is 16 feet, and the kiln takes 600 cubic feet of billets (stacked). Billets are stacked closely on end in three tiers, interstices being filled with sticks of a smaller dimension. Further details for stacking are lacking in the report as they are well-known. Four uprights (poles or bamboos) are used for the flue which is built up with dry brushwood tied with creepers before the billets are stacked. In order to form a suitable parabola the billets are stacked more and more away from the vertical as the periphery is approached, the greatest deviation from the vertical being in the topmost layer. In covering the dry-type kiln a layer of green leafy twigs is placed over the kiln and then an outer covering of dry earth. The height of the kiln so constructed is about five feet six inches. The flue protrudes and is left open. Apart from finding out whether charcoal from the dry-type kiln was suitable for producer-gas plants, we wanted to ascertain how it compared with charcoal from the wet-type kiln; so it was necessary in order to get reliable comparative results, that the same species and same sized billets should be used. The experiment was made with *Cleistanthus collinus,* a common species in the division, particularly in the drier localities. The kilns were supervised carefully.

There was a negligible difference in outturn, which, with both types, worked out to $6\frac{1}{2}$ maunds charcoal per 100 cubic feet of stacked billets. Charcoal from the two types of kiln was then subjected to test by the Government Test House, Alipore, Calcutta, and the test certificate gave the following data, in which Sample "A" is from the wet-type kiln and Sample "B" from the dry-type:

"Both samples were in the form of lumps of various sizes, the largest being approximately 3 in. cube in each case. They had a silver-grey lustre and larger lumps emitted a metallic ring when dropped on floor.

	(1)	(2)
	Sample marked "A."	*Sample marked "B"*
	Per cent.	*Per cent.*
Moisture ...	7.25	6.62
Proximate analysis on dried sample:		
Volatile matter ...	8.80	9.35
Fixed carbon ...	88.32	87.25
Ash ...	2.88	3.40
	100.00	100.00
Colour of ash	Light-grey.	Dirty-white
Calorific value on dried sample:		
Calories per gramme ...	7,835	7,704
B.T.U. per lb. ...	14,103	13,867

As regards their chemical compositions, the two samples are closely similar. They represent good-quality commercial wood-charcoal and are considered to be generally suitable for use in producer-gas plants."

As the charcoal from the dry-type kiln was found suitable, and as streams in the division dry up early in the year, even waterholes being extremely scarce, we adopted the method. Requirements of charcoal from the division are now 6,000 maunds a year. From experience, we have obtained information some of which was lacking in the Sambalpur report.

Method.—We have found a kiln of 500 cubic feet of billets (stacked) to be more suitable than one of 600 cubic feet, using a kiln of 16-foot diameter. The height is about five feet and a better angle of repose for the dry-earth covering is obtained. The flue is lit from the top and all ventilation except at ground level is stopped. As the fire gradually works downwards the flue is filled with billets and the top closed with twigs and earth. The ventilation at ground level is also closed, and a ring of ventilation holes is then opened about a foot below the top of the kiln. As carbonization proceeds, the smoke from the holes becomes lighter and bluish in colour. These ventilation holes are then closed and a fresh ring of holes opened further down, and so on till ground-level is reached with the third or fourth ring of holes.

Cost.—The work is paid for at contract rates based on a daily labour wage of four annas. The rates per 100 cubic feet of stacked billets are:

		Rs.	a.	p.
(*i*)	Billets	1	0	0
(*ii*)	Preparation, burning and opening of kiln	1	0	0
(*iii*)	Sorting and stacking of charcoal ...	0	4	0
	Total ...	2	4	0

Although in experimental test kilns six to seven maunds of charcoal have been obtained from 100 cubic feet of stacked billets, in practice with large-scale operations only five to six maunds can be expected. An outturn of less than five maunds is considered unsatisfactory.

This works out to about seven annas a maund and to this amount has to be added about two annas to cover supervision and contingencies, bringing the total cost of production to nine annas a maund. For the annual outturn of 6,000 maunds there are three supervisors, each superintending a number of kilns and drawing a monthly salary of Rs. 18. The supervisers as well as the labour have been trained by the Forest Department. They are paid by Messrs. Heilgers & Co., who require the charcoal for transport of produce for the Titaghur Paper Mills. The cost of outturn is exclusive of the royalty the company pay the Forest Department.

In the Sambalpur report the contract rates also come to a total of Rs. 2-4-0 per 100 cubic feet of stacked billets, and the cost of production of charcoal is given as Rs. 0-4-9 per maund exclusive of the cost of staff and contingencies. But this estimate of cost of production was based on an outturn of $7\frac{1}{2}$ maunds per 100 cubic feet of stacked billets, this being given as the possible outturn with well-supervised kilns. It is doubtful if the average outturn can have been nearly so high.

It is interesting to note that in Sambalpur the manufacture in all stages except the opening of kilns was done by female coolies. In Angul female labour will not do any of the work.

DOMESTIC OCCURRENCES

BURGESS.—On 30th July, 1943, at the Community Hospital, Landaur, Mussoorie, to Elizabeth, wife of F. G. Burgess, I.F.S., Timber Supply Officer, Dehra Dun, a son.

ROWNTREE.—On 4th September, 1943, at the Gonesh Das Hospital, Shillong, to Joy, wife of John B. Rowntree, I.F.S., Deputy Conservator of Forests, Jorhat, Assam, a daughter.

EXTRACTS

FORESTRY AND THE COUNTRYSIDE

BY J. H. S.

In almost every book published on the countryside the author, who is usuall) a lover of the landscape and of husbandry, deplores the extension of plantings. This is most disturbing to the forester who has his heart in the growing of trees, their health and yield, and who wishes to see once more the practice of forestry an established country industry. This article attempts to summarise the vexed question, and to show how with care and consideration both of the land itself and of the landscape, it should be possible for all to recognize the value of forests both commercially and as part of the landscape.

Let us consider the public's attitude, and that of the agitator against the re establishment of forests. There are two types of appreciation in the country. That of the permanent inhabitants is concerned chiefly with the cultivation of the land and the second, of the townsman who comes to admire the place where the first work. The countryman appreciates the qualities of the soil, where it gives good yields from crops or stock, or where in poor conditions a livelihood was wrested with ingenuity and resource from barrenness. The townsman comes from noise and smoke-fouled air and the drearier routine of town life to enjoy something more free, direct and bracing, which he finds out of town, and which is worth a certain lack of everyday comforts.

The first views the coming of forests with misgiving. It is a new thing which may upset the working of the ground and the local balance of work, and which is associated with the covert plantings of former days of sport. The second sees the waste lands he has come to appreciate as places untouched by man fenced and regimented, taking on the very character of orderly management which he associates with everyday work, which he tries to escape when he can.

Both in their attitude show little land sense and no forest sense. The farmer is loath to realize that in the general scheme for the whole country in relation to the whole world it may be better policy to replace with forest inferior sheep walks and poor steep rocky country carrying bracken and little else, or land too steep to plough, too rough for dairy cattle. He may suffer from heavy floods, but will not see that trees in the poor hillsides will control stream flow, absorb heavy rains and reduce spates, storing water for summer.

The visitor is appalled by "commercial forestry." The regimentation of hard lines of small trees horrifies him, though the regimentation of drilled corn, or potato ridges gives him pleasure, as do neat farms and straight dykes across the hills bounding sheep farms. The countryman will be converted by results in two generations, though his numbers mean that he has scant say in Press and Government. The visitor who is chiefly interested in the land for his holiday can only be converted by firm planning and education.

The causes of depression in the present countryside are well known. Both farm and forest have suffered from cheap imports and make-shift policy, and have been affected by the chaotic state of world economics up to 1939. The forests, much more than the farms, have suffered from the precedence of sport, and archaic systems well suited to shooting have survived. The re-establishment of forests by private individuals has been tackled without knowledge and without much aid from the state. The townsman has come to look on a forest as an expanse of overmature worthless scrub or an unthinned dank block of emaciated conifers.

Experience in the last war and in this has shown how vital a reserve of timber is in wartime, and how little skilled labour is now available to work it. The lack of forest sense is the great cause of the unpopularity of forestry and everything possible must be done to revive and foster a care for the land and its planned utilization.

But forest sense is not only lacking in the general public and the particular countryman but in the forester. The R.E.F.S. and the R.S.F.S. have for their badges gnarled trees which would please no forester on a 50-acre stand. The visitors' experience of plantations are underthinned damp areas where there is no light, not a flower, where the smell is of damp fungus. The trees are like corn, spindly and tall, and quite often blown like corn. He sees hillsides swamped with even masses of Scots pine or Sitka and Norway spruce, he sees curtains of trees obscuring a fine view, a hard line at the planting's upper limits, fire traces running at regular intervals up and down the hills. If he be bold, and aware of how he should behave in a wood he may venture into the forest and find no tracks, or wander, if he be in luck, along dark tunnel rides in a damp silence, cut off from view and sky and life.

This is the forester's fault in two ways. He must practise good silviculture and in order to educate the public he must do it tactfully.

Sound silviculture will go far to make the country pleasant to the eye. To utilize the ground he must thin: his healthy stands will improve the landscape. He must make provision for the removal of his produce, and must make good roads. He must set aside areas for converting produce, and will provide a view from these. He must make use of every inch of ground, arranging his plantings to suit each site, putting the right species on each area. Yield regulation must be in respect of site—his boundary rides and paths will not always follow hard lines. The monotonous blankets of single species will disappear. The broken colours of scrub and grass, heather and bracken will be replaced by patches of larches, spruces, pines and firs, by ash, oak, beech and sycamore. He requires hardwoods to keep his soil sweet, he will let the visitor appreciate his woods by their groups and patches. He will have to experiment with species on trial areas on different sites. Let these be accessible where possible with explanatory notices so that all may be interested. He must warn people against fire. Let his notices be courteous. His fire traces along roads should be wide enough for ornamental trees to be planted, and he may give facilities here for visitors to picnic in pleasant surroundings. Fire traces in the wood will be needed to break up great masses of timer. The ground fire traces will be inadequate against crown fires, so he should make them wide with screening lines of hardwoods. His spacing must conform with natural features—the breaks will not be regular nor necessarily straight.

With better forest practice and wise State administration local industries in forest areas may be established. Turneries and plywood plants will require hardwoods, and there will always be a market for fine stems of beautiful timbers. The forester must consider carefully whether parts of his soils are better suited by hardwoods—they are easy to regenerate, and are good to look at.

The forester, then, by being efficient will do much to educate the public. There will still be much to be done however. The Forestry Commission has so far borne much of the criticism. A country with forest sense would have welcomed its formation. Pressed as they were after the last war to provide a national reserve of timber in a future emergency the Commissioners got on with the job, meeting considerable antagonism where they acquired land that had lost its value to the owners in the more picturesque parts of the country. Early planting may have been piecemeal, but great care in planting species according to small changes in site is now practised.

The antagonism of organized preservation societies will largely depend on the excellence of post-war planning and the degree of security then felt. Given good plans it will be possible to provide amenities accruing not only from good forestry but roads in the forest for walking at least, rest houses and youth hostels, and reserves for observation of wild life. Established woods should, where practical, be worked on irregular principles about which there should be some publicity, for not only is it the most efficient way of growing good timber but its amenity value is great, doing away with extensive clear-fellings and even-aged plantings.

With good plans the landscape will be changed, but not blanketed. For the countryman there will be new work and industries, regulated streams, an efficient landscape. For the visitor will be an added interest to his holiday, a realization that felling is harvest, not destruction, a new place to walk, cool in summer, warm in winter, a permanent beautiful thing that has been long neglected and forgotten, something that is valuable, productive and to be proud of.

Already the dull masses of bare wintry oak woods in Wales shine with the warm green of Douglas fir, the red and yellow twigs of larch, the grey of ash. Once the prejudice has gone our authors of books on the countryside will praise them.—*Quarterly Journal of Forestry*, dated January, 1943.

MANURES AND MANURING

By Sudhir Chowdhury

CHAPTER I

Historical

The use of the dung of animals and of chalk, marl, wood ashes, and certain other substances for increasing the productivity of the soil, was known not only to the early Greeks and Romans but apparently also to the Chinese whose employment of them for such purposes probably far antedates all human records. Indeed, Mago, the king of Carthage, in his work on agriculture, which won for him from his enemies, the Romans, the designation 'Father of Agriculture,' wrote of the value of bird manure, praising especially that of pigeons, and Cato (born 234 B.C.), the first

Roman agricultural writer, gave to bird manure the first place. The manurial effect of various miscellaneous substances and of certain legumes was also well recognized not only by the agricultural writers Varro (39 B.C.) and Columella (50 A.D.) but even by the poet Virgil, for the latter in speaking of ashes and dung says:

"But sweet vicissitudes of rest and toil make easy labour and renew the soil;

"Yet sprinkle sordid ashes all around, and load with fattening dung the fallow ground."

Nevertheless, although the beneficial effects of manuring have long been recognized, it is only since the beginning of the last century with the development of the science of agricultural chemistry, that any accurate knowledge has been obtained of the functions of manures and the principles of manuring. One of the first questions which suggests itself in connection with the functions of manures and the principles of manuring is: of what materials are plants made up and from whence do they obtain them?

To this question no satisfactory answer could be given by the earlier chemists. They were too much addicted to explaining natural phenomena by recourse to imaginary 'first principles' or 'elements' (the latter word, however, not being used in its modern sense, but rather as representing such qualities as 'hotness', 'dryness', 'coldness', or 'moistness'). For example, some of the alchemists attribute plant growth to a 'balsamick saline juice', present in fertile, but deficient in barren soils. One of the earliest theories as to the nature of the food of plants was that of Joannes Baptista van Helmont, one of the best known of the alchemists who flourished about the beginning of the 17th century. Van Helmont, believed that he had proved by a conclusive experiment that all products of vegetables are generated from water.

"He took a given weight of dry soil—200 lbs.—and into this he planted a willow tree that weighed 5 lbs., and he watered this carefully from time to time with pure rain water, taking care to prevent any dust or dirt falling onto the earth in which the plant grew. He allowed this to go on growing for five years and at the end of that period, thinking his experiment had been conducted sufficiently long, he pulled up his tree by the roots, shook all the earth off, dried the earth again, weighed the earth and weighed the plant. He found that the plant now weighed 169 lbs. 3 ozs., whereas the weight of the soil remained very nearly what it was—about 200 lbs. It had only lost 2 ozs. in weight." The conclusion, therefore, come to by van Helmont was *that the food of plants was water.*

The next theory as to the nature of the food of plants was that of Jethro Tull, which when it was first published created a considerable amount of interest. About 1,700 Jethro Tull convinced himself that the growth of plants depended upon the fineness of the particles of the soil in which they were grown, and in a book which attained some celebrity—'Horse-hoeing Husbandry', the first part of which was published in 1731, he taught that the use of manure was unnecessary if the soil were mechanically reduced to a sufficiently fine state of sub-division. Therefore he argued if this work of pulverization can be effected more cheaply by tillage operations, manures might be dispensed with. According to Tull the food of plants consists of the particles of the soil.

The first serious effort to get the facts about the food of plants was made in 1755 by Francis Home who was requested by the Edinburgh Society for the Improvement of Arts and Manufacture 'to try how far Chymistry will go in settling the principles of agriculture.' He recognised that the central purpose of agriculture was the feeding of plants and therefore began to study this, adopting two methods that have since been followed by many other investigators: the analysis of the plant to discover what is in it, and the testing in pot experiments of the effects of various substances on plant growth to discover those that are of real nutritive value. Home himself did not get far with the problem but the introduction of the method by which it would be solved was a great achievement.

Further advances were made by Priestly in England and by Ingenhousz and Senebir in Geneva. In 1772 Priestly discovered that combustion and the respiration of animals deteriorate the air and lessen its volume but that plants can render it again capable of supporting combustion. This observation coupled with his discovery of oxygen led to the recognition of the fact that the bubbles already observed by Bonnet on leaves when they were immersed in water, were chiefly oxygen. It was then shown by Ingenhousz that these phenomena were caused by the action of sun-light, and Senebir established the fact that the oxygen evolved by plants resulted from the decomposition of the carbon dioxide already taken up from the air, a fact demonstrated in a quantitative way by de Saussure.

Theodore de Saussure of Geneva, son of a famous botanist of the same city was the first to draw attention to the mineral or ash constituents of the plant. He maintained that these ash ingredients were essential and that without them plant-life was impossible. He did experiments to show that plants obtain their carbon from carbon dioxide in the air, under the influence of the sun-light. He was of the opinion that the hydrogen and oxygen of the plant were probably chiefly derived from water. He showed that by far the largest portion of the plant's substance was derived from the air and from water and that the ash portion was alone derived from the soil. His work was published in 1804 in a small volume called *Recherches Chimiques sur la Vegetation,* one of the most fascinating books on the subject ever published. But it met the same fate as many another scientific book; it was ignored for a long time.

To de Saussure we owe the first definite statement on the different sources of the plant's food.

During the first thirty years or so of the 19th century little advance was made except that two chemists Humphrey Davy in England and von Thaer in Germany were collecting and examining the farmers' knowledge about manuring and putting it into terms that chemists could understand. Towards the middle of the 19th century, however, the subject received more and more attention and great advances were made in our knowledge of plant growth.

J. B. Boussingault, a very able Frenchman, after adventurous travel in South America, settled down on his farm at Bachelbronn in Alsace and commenced about 1835 a series of field experiments in which for the first time the scientific method of measuring all relevant matters was adopted. He weighed and analysed the manures applied and the crops obtained, and at the end of the rotation, drew up a balance

sheet showing how far the manure had satisfied the needs of the crop and how far other sources of supply—the air, the rain and the soil—had been drawn upon. These measurements accorded exactly with the work of the plan physiologists and showed that:

(1) "The main part of the crop is composed of carbon, oxygen and hydrogen, most, if not all of which comes from the air and from water and not from the organic matter of the soil;

(2) "The nitrogen of the crop comes largely, if not entirely from the soil or from manure;

(3) "Mineral matter is an essential part of the crop and it comes from the soil or from manure."

Notwithstanding the investigations of those who had preceded him, Justus von Liebig soon became the great central agricultural figure in 1840. Liebig controverted the so-called 'humus theory' *viz.*, that the plants obtain the greater part of their substance from the organic matter of the soil, a view first distinctly taught by Einhof and Thaer about the end of the 18th century and still widely held. And then in treating of the relation of the soil to the plant, Liebig put forward his 'mineral theory': that if plants are supplied with the small quantity of mineral matter of the ash the remainder of their substance can be drawn from the air. He was the first fully to estimate the enormous importance of the mineral portion of the plant's food and to restate in a more emphatic manner the views of de Saussure on this subject. He pointed out that the most important constituents of manures were phosphates and potash, and though at first he also included combined nitrogen, in his later expressions he failed to appreciate the value of nitrogenous manures, holding that a sufficient amount is washed from the atmosphere in the form of ammonia. It appears that Liebig was greatly in error when he expressed the view that combined nitrogen is not an important constituent of manures and that a sufficient amount is washed form the atmosphere in the form of ammonia.

A practical improvement which we owe to Liebig is the manufacture and use of 'dissolved bones' and superphosphates. Bones as a manure began to be used about 1775, it is said, first in Yorkshire, and their value was so much realised by English farmers that they were imported in large quantities from the continent of Europe. Liebig in 1840 discovered that by treatment with sulphuric acid, bones could be greatly improved as a fertilizer, being rendered thereby much quicker in action and, in every way more efficacious.

Just before this time, John Bennet Lawes, the young squire of Rothamsted had been making a number of experiments to try out the manurial effects of various substances. Observing the young man's tendency to experiment, a neighbouring landowner, Lord Dacre, asked him to try and find out why bones, so useful in other parts of England, were of little value on the Rothamsted and surrounding farms. Some years before this time chemists had been studying the composition of bones and had proved the presence of calcium and phosphorus in the combination known as phosphate. They had also discovered other phosphates of calcium, three in all,

of which one was soluble in water and the other two not. The soluble one called superphosphate of lime could be prepared from the insoluble ones simply by treatment with an acid such as sulphuric or hydrochloric. Lawes knew of these results and he recognised their bearing on Lord Dacre's problem. He knew that the phosphate in bone is insoluble, but can be made soluble by treatment with sulphuric acid, and thought it probable that the soluble phosphate would be more easily taken up by the plant than the insoluble one. He, therefore, tested this 'dissolved bone' in the field and showed that it was an effective fertilizer. The discovery was interesting but not in itself of far-reaching importance because bones were dear and would probably always remain so.

But about that time geologists were discovering vast deposits of mineral calcium phosphate for which little use was apparent. Lawes knew from the chemical results that this mineral phosphate, after treatment with sulphuric acid, would give precisely the same soluble phosphate as bones, and he argued that it ought to be as useful as bones, besides being much cheaper and far more abundant. In a barn at Rothamsted that had been converted into a laboratory, a few hundredweights of superphosphate were made from mineral phosphate. This superphosphate was tried on the so-called Barn-field lying just outside and found to be very effective. After further trial but not without some misgiving because the manure trade was not then the kind of thing a gentleman indulged in, Lawes in 1842 took out a patent and set up a factory at Deptford, where superphosphate and other fertilizers were made, and as they were manufactured they were given the name 'artificial fertilizers.'

In another set of pot and field experiments Lawes had shown that sulphate of ammonia increases plant growth. He seems to have tried this material because it could be obtained cheaply from the gas works, there being little demand for it; but he, and still more Gilbert, a former student of Liebig who associated himself with Lawes in 1843, recognised clearly the underlying scientific fact that the sulphate of amonia contained nitrogen and they showed that the plant benifited by an increased supply.

Their field experiments were on wheat and turnips, then two of the most important crops in England, and they showed that the yield of wheat could be raised from 20 bushels per acre, the customary yield at Rothamsted, to over 30 bushels simply by the addition of a few hundredweights per acre of the cheap superphosphate and sulphate of ammonia. Marked increases were obtained in yields of turnips and, in later experiments, of barley, grass and other crops. The financial results were eminently satisfactory, and progressive farmers, quickly took up the new 'artificial fertilizers.'

The new industry was not without its troubles on the scientific side. Lawes soon became involved in a controversy with Liebig, who maintained that plants derive all their nitrogen from the air and need no artificial supply. The Rothamsted field plots showed that Lawes was right, but Liebig remained unconvinced and denounced the Rothamsted experiments in the most scathing terms.

The controversy had at any rate the good result that it led Lawes and Gilbert to continue their field experiments year after year on the same ground to demon-

strate the ferilizer value of nitrogenous compounds, and they did this long after Liebig's case was lost. The elaborate experiments conducted at Rothamsted by Lawes, Gilbert and Pugh in 1857 proved conclusively that a supply of combined nitrogen in the soil was absolutely necessary for the successful growth of plants. In fact, in the course of the experiments at Rothamsted in which the soil was sterilized without thought of the consequences, it was concluded that the gain in nitrogen by legumes was due merely to their great feeding range by virtue of sending their roots so deeply into the soil—a conclusion which for several years received world-wide acceptance.

On the practical side there were many farmers and agricultural writers who refused to believe that 'artificial fertilizers' made in a factory and sold in bags could possibly do anything but poison the ground. Wren-Hoskyns described this attitude well: the "smiles, winks, murmurings, shakes of the foreboding head, and other demonstrations, jocular and serious" when the manure was 'sown'—a ludicrous idea to the old men of the time.

As far as Lawes himself was concerned the times seemed almost desperate. He had to amend his patent and discard bones for it was proved that Liebig had already advised farmers to treat bones with sulphuric acid for the purpose of making them more effective as a fertilizer. Various people set up manufacturing processes that either infringed his amended patent or seriously reduced the value of his monopoly. In 1852, therefore, he began a law suit against them. The law suit must have proved costly; in the end Lawes won on some counts but not on all. He straightened matters up, however, by buying out the opponent, who had doubtless found the law suit equally exhausting.

After this came a period of brilliant prosperity, lasting with some ups and downs from about 1855 to 1874. The lessons of the Rothamsted experiments continued year after year, whatever the season and whatever the financial outlook. 'Artificial fertilizers' became firmly established as part of the routine of farm practice, and their manufacture became an important British industry, enjoying good home markets and a substantial export trade. The fertilizer industry, in fact, including also the trade in Chilean nitrate and guano, became to a considerable degree centred in British hands. Other countries have since learned to manufacture superphosphate so that this is no longer a British monopoly, nor is Britain any longer the largest producer; North America, France and Italy, all much exceed British production now.

There was, however, still one point which remained somewhat unintelligible—the gain in combined nitrogen which seemed to take place when certain crops of the leguminous order were grown. Boussingault in his earliest investigations had shown that in certain rotations which included clover or lucern, more nitrogen is removed in the crop than was supplied in the manure, and many of the Rothamsted results could only be explained on the assumption that the roots of such crops ranged exceptionally deep and drew upon stores of subsoil nitrogen unavoidable to other plants. It was not until 1886 that these difficulties were cleared by the discovery of Hellriegel and Wilfarth that leguminous plants fix the atmospheric nitrogen by the help of certain bacteria living in symbiosis upon the root of the leguminous

plant. The leguminous plant, however, will aso feed upon combined nitrogen in the soil like any other plant, and the failure of Lawes and Gilbert to detect any nitrogen fixation in their laboratory experiments with beans and clover, was due to the great care to shut out any intrusion of foreign matter during the experiments, thus preventing the leguminous plants from being inoculated with the bacteria causing fixation and also due to the fact that in most cases soils were sterilized.

A more recent scientific triumph has been the production of nitrogenous fertilizers from the air. For many years England was the chief producer of these fertilizers, being the largest user of coal from which sulphate of ammonia was made, and owning the largest interests in the Chile nitrate fields. Extensive, as these resources were, it was by no means certain that they could long have continued to satisfy the demand, and in 1898, in his famous address to the British Association, Sir William Crookes took a distinctly pessimistic view. As a man of science he tempered his pessimism by pointing the way out. He showed that an old laboratory experiment made by Cavendish in 1783 and repeated by thousands of chemical students throughout the 19th century without much thought as to its significance, could be turned to the manufacture of 'artificial fertilizers' from the air. The experiment had consisted in the passing of an electric spark through the air, whereby some of the oxygen and nitrogen combined. By the substitution for a large arc for the spark, large quantities of nitrates could be made.

The Norwegian chemists and engineers immediately took the matter up utilizing their cheap water power for the generation of the electricity. The Swedes quickly followed by a different process, due to Caro, which produced calcium cyanamide; this the Italians, the Swiss and the Americans have since developed. Both processes, especially the Norwegian, required considerable power. In Germany the Haber process was devised for effecting the combination of nitrogen and hydrogen at moderately high temperature and pressure. This requires little power, but a high standard of scientific and technical attainment on the part of the staff; it was developed to a remarkable extent during the war and is now used in Germany by the I. G. Farbenindustrie Aktiengesellschaft, the largest producer of synthetic nitrogen compounds in the world. During and since the war a modification of the process was worked out in England, and now Imperial Chemical Industries, Limited, operating at Billingham, near Stockton on Tees, is already the second largest producer of synthetic nitrogen compounds.

In the preceding paragraphs a short account has been given, touching only the salient features of the development of the science of manures, the food of plants, and the manufacture of 'artificial fertilizers.' Since 1840 progress in the different branches of agriculture and especially in the science of manures has been much more rapid, and it has, therefore, been not possible to give a detailed account of the many advances that have been made. In subsequent chapters reference will be made to the discoveries that have been made and the knowledge gained.—*The Allahabad Farmer*, Vol. XVII, No. 3, dated May, 1943.

THE PLACE OF FIRE PROTECTION* IN FOREST EDUCATION

BY GEORGE M. JEMISON

Forester, in charge Forest Fire Research Appalachian Forest Experiment Station.

In terms of the relative demand on all forest appropriations and on the time and competence of foresters, as well as in terms of the technical knowledge and skills required, protection of wild lands from fire still comes first in this distinctive American forestry undertaking to-day. Yet forestry schools devote four per cent. or less of their technical forestry curriculum to preparing their forestry students for this important responsibility. The author challenges the persistent attitude of some educators that protection from fire is mostly a vocational or shirt-sleeve job and largely incapable of a scientific academic treatment.

* * * *

Substantial progress has been made in forest education during recent years. Educators have so carefully analysed and revised the curricula at many institutions that young men entering professional forestry are now able not only to obtain an adequate training in basic subjects but to specialize in a variety of broad forestry fields.

Minimum educational requirements for students who expect to qualify as professional foresters are quite debatable, as the pages of the *Journal* have demonstrated during the past eight or 10 years. If there is general agreement on these requirements, one might conclude that about 60 or 70 per cent. of undergraduate time should be given to training in fundamental arts and sciences with 30 to 40 per cent. assigned to technical forestry. In addition, the majority of educators in forestry recommend a five-year educational programme where possible, which permits a greater degree of specialization in one of the broader fields such as timber management, utilization, wild-life management, or range management.

The foregoing general requirements are accepted, but continued progress in forest education necessitates continued adjustment of the schedules which guide the technical training of students the better to prepare them for the jobs they will have to do as professional foresters. A retrogression to the "trade-school" type of education is not advocated and the recent changes in curricula leading to sound training in basic subjects is fully supported. The present emphasis given to the technical forestry subjects is the point of this discussion.

Emphasis given to Fire Protection.—In view of the basic importance of the work, the time required by it and the rapid recent advances in knowledge in that field, emphasis should be given to instruction in fire protection. It is estimated that 35 per cent. of the working time of the average professional forester in the United States is spent on some phase of fire prevention or control. In one eastern Forest Service region, about 70 cents out of every dollar spent is invested in fire protection excluding maintenance and improvement of roads, trails, communication lines and structures. Of the total forestry appropriations in 1937-38 for all activities by state forestry organisations, 47 per cent. was allotted to fire protection.† Exclusive of

*In this paper fire protection is defined as the protection of wild lands and the growth thereon from fire. It includes prevention, preparedness and suppression and is synonymous with "fire control" as defined in *Glossary of terms used in forest fire control.* U.S. Dep. Agric., Forest Service. 1939.

† State forests for public use. U.S. Dept. Agric. Misc. Pub. 373., pp. 33-34, 1940.

money appropriated for land acquisition. 56 per cent. of the total 7.2 million state dollars was allotted to fire protection. Private forestry organisations spent 1.3 million dollars as well, in 1937, for fire protection, and this figure undoubtedly amounts to a large fraction of their forestry expenditures. With the sum spent by all federal fire protection agencies, the grand total bill for fire prevention and control by all organisations approximates $25,000,000 a year.

In view of this obvious evidence of the extent of the field of fire control, what kind of technical training is the average forestry school student getting in fire protection? Of 21 forestry schools the curricula of which were checked, four require no course at all in this subject. Eight require a course which covers all aspects of forest protection including protection from insects, disease, animals and weather as well as from fire. Approximately two-and-a-half semester hours is the average protection-course requirement of the 17 schools that have this subject in their 1940-41 curricula. The fire-protection fraction of this requirement represents an average of only three to four per cent. of the total time allotted to all technical-forestry subjects. Most schools require fire-protection studies in only one or two of the several specialized curricula (forest management, utilization, range management, etc.) offered, which seem to be a desirable arrangement.

Chapman's 1935 report on professional forestry schools shows how the amount of instruction given in forest protection (protection from fire, insects and disease) at 21 schools compares with that in other technical, forestry fields. In 1935, 26 per cent. of the technical forestry, taught in the average curriculum was silviculture, 26 per cent. was management, 19 per cent. was utilization, 10 per cent. was forest protection and 8 per cent. was economics, with the remainder divided among miscellaneous subjects. Probably then, as now, not more than three or four per cent. of the total time allotted to forestry subjects was given to fire protection.

The writer disagrees emphatically with those who maintain, as many have, that fire protection is a subject that cannot well be taught, that it is best "picked up" on the job, that it consists of rules-of-thumb and its application is so modified by local conditions that it should not be included among technical-forestry subjects except to provide a general survey of the field of fire protection. In opposition to this viewpoint the writer believes that fire protection embodies a field of knowledge based on sound scientific principles and methods, and in itself constitutes a science. "Forest pyrology," Gisborne* has called it, with a background of fundamental sciences comparable to that of the already-recognized fields of pathology and entomology. An understanding of the latter two sciences does not begin and end with the pulling of currant bushes or with peeling bark from "bug" trees. Neither does fire protection begin and end with digging a trench around a fire. All three sciences of fire protection—pathology, entomology and pyrology—have "organisms" the "life history" of which must be understood by a well-trained technical forester who would plan and execute prevention and control measures. In the case of pyrology the organism, is fire, which obeys specific physical and chemical laws as insects or fungi obey biological laws. Psychological and sociological aspects of fire protection complicate this field.

* Gisborne, H. T, Forest pyrology. *The Scientific Monthly*, 44: 21—30. 1939.

Graves and Guise* include an extremely pertinent paragraph in their discussion of fire protection. This follows in part:

"Protection against fire influences practically every activity in handling forests. . . . it must be kept in mind in the instruction of all subjects of applied forestry. In a well-co-ordinated curriculum there should be constant reference to forest fires and protection in the several technical courses to enable the student to understand the relation of protection to other features of forestry protection. . . ."

Like silviculture, good fire suppression is a distinct art. But also like silviculture, the attainment of a high degree of efficiency in this art must rest upon knowledge of fundamental sciences as well as upon field experience. Successful fire prevention often requires an understanding of social sciences as well, and one who prepares sound prevention-and-control plans must possess a keen knowledge of economics. The field of fire-control economics is, in itself, a specialized one in which conventional treatment of the subject fails to consider adequately several of the most important benefits of fire control.

Fire protection is a subject which lends itself admirably to the development of a student's ability to reason. Often the greatest value of school-training lies not in the particular subject matter but in stimulating independent thought. Fire protection, because it is the first essential of forest-land management and because of its close relation to physical and social sciences, provides a field for much constructive thought and discussion. In addition, training in prevention and control will equip young foresters to handle better the jobs in which the majority will find themselves immediately after leaving school.

In view of the demands made upon the average professional forester by his fire-protection job, and because of the progress in the science of prevention and control and the present inadequacies of education in this field, a four-year undergraduate course in forestry should contain a minimum of six semester hours of fire protection; better yet, eight hours or about three times the present average time allotted to the subject. Trebling the fire-protection requirement would mean that about 10 per cent. of the time given to technical forestry subjects would be spent on prevention and control or on related subjects. No school at present requires from undergraduates this much work in this field. Time would be crowded to include fundamental meteorology: psychological, sociological and legal aspects of prevention; basic principles governing fire behaviour; the economics of fire protection; fire-planning methodology; suppression techniques; and effects of fire and its uses in various types of land management.

Specialized Training in Fire Protection.—A second point in connection with the place of fire protection in forestry education deals with the opportunities available for students to specialize in the fire field. Graves and Guise list five broad forestry fields in which specialized technical training may be given—Forest protection (including fire, pathology and entomology), silviculture, management, utilization and economics and policy.

---

*Graves, Henry S. and Cedric R. Guise. "Forests education." 421 pp. Yale University Press. 1932.

There is no school in the country that offers a curriculum specifically planned for the student who wishes to become a fire specialist. It seems highly desirable that at least one or two schools provide carefully-planned instruction in fire protection, especially in view of the universal importance of this work and the ultimate extension of organized protection to new, unprotected forest land. The hearings before the Joint Committee on Forestry brought out the fact that private and public forestry agencies all stress the need for more and better fire protection, particularly in the south, where at present 56 per cent. of the forest land is unprotected. The report of this committee* listed as its first recommendation the authorization of a 10-million-dollar federal expenditure for co-operative fire protection on private and state-owned forest lands. Who is going to determine the most efficient way of spending this money whenever it may become available? Certainly well-trained fire specialists would be needed to help plan and direct such expenditures. No one can logically maintain that even the present co-operative funds of only 2.5 million dollars are being spent everywhere in the most efficient manner.

A high grade of specialized instruction in forest fire protection, carefully woven into a five-year forestry curriculum, would produce specialists who, with experience, would be able to further protection effort in this country. The need for trained fire-research men as well as administrators is especially keen at this time. The South offers exceptional opportunities for specialized education in fire protection because the fire problem there involves, in a major way, prevention, presuppression, suppression as well as beneficial use of fire. Opportunities for field study are abundant and, combined with outdoor laboratory work, studies in all phases of fire protection could be conducted technically and efficiently.

There is a final point in support of more adequate facilities for general and specialized instruction in fire protection. The field of fire prevention and control is distinct from most other forestry fields because as fire objectives are approached in the future, more and more time and money can be diverted to forest production. The fire protectionist group is actually trying to work itself out of a job. An adequate basic training in the science of fire prevention and control will hasten the time when foresters can turn more of their attention to growing forest crops.—*Journal of Forestry*, Vol. 40, No. 11, dated November, 1942.

---

* Report of the Joint Committee on Forestry, 77th Congress Senate, Document No. 32, 1941.

INDIAN FORESTER

NOVEMBER, 1943

WHAT IS FORESTRY?

BY SIR HERBERT HOWARD, I.F.S.,

Inspector-General of Forests.

(A lecture delivered to the 17th British General Hospital and other officers at Dehra Dun)

Many years ago when I was training to be forester, I was travelling across France and, in the restaurant car, in answer to various questions of the man opposite me, I told him that I was a forester and that I was going to the Black Forest. "Oh!" he said "Why are you going there, are they going to cut it down?" That was all that forestry meant to him and he was an educated and apparently an intelligent man. Forestry certainly does not merely mean cutting down trees.

Before I tell you what forestry is, that is, what a forester's job is, I propose to tell you a little about the usefulness of forests.

The most obvious things that man gets from forests are timber and fuel which are called major forest produce. But in addition there are various other articles which are neither timber nor fuel and which the forester calls minor forest produce, though they may be far more valuable than either timber or fuel. Rubber, for instance, is a minor forest product. It is so valuable and its production so specialized, that it has long ago passed out of the sphere of the forester and has become the specialized industry of rubber planting. But the moment an acute rubber shortage arose, because the Japanese had captured the islands which produce some 90 per cent. of the total rubber supply of the world, the forester was immediately asked again to produce rubber from wild forest plants, as he had done years before rubber plantations were ever heard of. And it was the forester, and in particular this Forest Research Institute at Dehra Dun, which, within a month or two, was able to supply particulars of all the wild forest plants likely to produce rubber.

If you think rubber has become too specialized to be considered any longer as a forest product, then there is another minor forest product obtained by tapping trees in much the same way as trees are tapped for rubber, namely, pine resin. That is still entirely a forest industry and the resin is tapped, collected and exported by the forest department. Resin is a very important product as it is broken down into turpentine, which is a solvent for all the best paints, and rosin, which is not merely used to rub on a violin bow, but also to size paper without which you could not write on it with ink.

I told you that a forester's job was not merely cutting down trees. Having grown the timber, that is almost the end of his part of the business, though he may

undertake or at least supervise, the felling, sawing and export at any rate to his forest boundary. He does this partly because under many systems of forest management careless felling can do more damage than the felled timber is worth, and partly because he often works in remote tracts where he must do everything himself. Inside his own forest division the forester designs and builds his own bungalows and bridges, makes his own roads, and erects and runs his own sawmills. On occasions he may build and run his own railways and in the Andamans even command his own ships. One of my rangers gained a British Empire Medal for bringing four small ships on a seven days' voyage from the Andamans to India when the Japs arrived, and all he knew of navigation he learnt in a few hours before he sailed. His methods were rather like those of Christopher Columbus, but he got the ships in and the Navy is now using them. Once the tree has been converted into what you understand as timber, it usually ceases to be the care of the forester and becomes then merely the raw material for trade and passes to the timber merchant.

I doubt if any of you realize how dependent you are on wood and on forests. When you see the number of articles which used to be made of wood, but which are now made of other materials, you may think that the importance of forestry is likely to decrease. Far from it. Statistics show that, despite the many substitutes for wood, the consumption of wood per head of population is still rising in every country of the world. And if you think for a minute, you will find that you are completely dependent on the products of the forest at every moment of your lives. Beds, furniture, a large part of all buildings, all ships' decks and fittings and hosts of other articles are still made of wood. In recent years the use of thin pieces of wood stuck together, called plywood, is becoming more and more important, and even the modern aeroplane contains a large amount of plywood in it. Nor is that the end of it. Some of you may have heard of the *Daily Mail* and the *Daily Mirror*! Both are printed on newsprint made entirely from wood pulp. You may have heard of artificial silk stockings! They are not actually made of wood pulp because there are other vegetable fibres easier to use at the moment, but they can be made perfectly well of wood pulp, and probably are so made in Germany at present. Even the dye used for a large number of materials is obtained from the forest. The well-known drug Ephedrine is another article produced from a small forest plant called "Ephedra." And when the doctors have finished killing you with that or some other drug, you still cannot get away from the forest because you will then be buried in a wooden coffin!

Those are some of the direct uses of forests. But there are many indirect benefits. The ruthless laying waste of forests over large areas brings in its train a terrible punishment. In our own sheltered land of Britain the effects of disforestation are not so drastic and not so apparent as in some other lands. I forget the exact rainfall in London but it is about 30 inches a year. But you all know that it rains more often than not. You all know that if, by any chance, a week passes without rain, our old friend the *Daily Mail* comes out with enormous posters talking about "the seventh day of drought." You equally well know that if you get a week's fine weather, about warm enough to dispense with your overcoat, again our old friend comes out with placards about the "heat wave" and the "number of deaths from heat

stroke." Here in Dehra Dun, where for many months on end you may see comparatively little rain, and where for only three months in the year do you get a considerable number of rainy days, the total annual rainfall is nearer 90 inches, something like three times that which falls in London. The result is that while the gentle and continuous rain of London does comparatively little harm on areas devoid of tree growth, in India, where 90 inches fall in three months and where it is quite common for three months London rainfall to fall in 24 hours, the tremendous scouring effects of the floods on bare land can carry away hundreds of tons of soil in a day, eventually reducing the land to little more than a desert. Look at the hills below Simla and you will see it happening, but on the Siwaliks to the south of Dehra Dun, where the forest department have cared for the trees for the last 70 years, there is no longer any danger.

And now having told you something of the uses of forests to man, I will try and tell you what a forester does—what forestry actually is. When man first needed wood or fuel, he cut down trees and used them. Thus, the first branch of forestry which arose is that which is now called "Forest Utilization."

As population increased and more trees were cut, men began to wonder whether the supply of timber and fuel would be everlasting. People then began to claim the ownership of areas and one way and another, there arose another great branch of forestry called "Forest Protection." This branch, though it started as a method of preserving the forest against the depredations of man, was eventually extended against those more subtle forms of damage like the attacks of injurious insects or injurious plants.

Gradually, however, it was found that more protection was needed to the forest than could be afforded merely by a protective staff, and so the State was brought into it and a whole succession of Forest Laws and Ordinances were promulgated.

But it was soon found that mere haphazard cutting and general protection was not sufficient. Nature unaided did not do all that was necessary for the forest, even though it was protected. It was soon found that it required a great deal of skill to grow trees. If they were to be reproduced by the living tree itself sowing the natural seed, it was found that fellings could not be haphazard, but that they must be conducted so that just sufficient light was admitted for the particular species of tree. Too much light, for instance, would turn a valuable oak and beech forest into a mass of brambles or in India a valuable *sal* forest into a sea of grass. Moreover, nature sometimes refused to reproduce the particular trees that were wanted. The forester then had to learn how to raise those trees artificially in nurseries and how to plant them into that part of the forest where he needed them.

But even that was not sufficient. Left entirely to themselves trees struggle together and, as a result of this continual struggle, the weaker individuals are killed, and only the fittest survive to produce those old trees which eventually furnish good timber. But there is a continual battle between the various individual trees which form the forest. The forester therefore helps them by thinning them out before the most exhausting stage of the battle occurs, thereby saving the strength of the individuals left to put into growth instead of into merely suppressing their neighbours. Trees can waste in fighting the strength which might be employed far better

in producing useful material, in exactly the same way, unfortunately, as we are being forced at the moment to waste our substance in fighting, instead of using the same energy and wealth to produce conditions to raise the standard of life for all of us. These operations gave rise to another great branch of forestry, and in a sense the most fundamental branch of all, namely, "Silviculture" or, if you like, the cultivation of forest crops.

Incidentally the forester soon found that trees would not grow everywhere. Some species liked one sort of soil and other species liked another sort of soil and part of silviculture is this knowledge of the particular type of soil preferred by a particular type of tree.

But still the whole of what is covered by "forestry" is not complete. As forestry became more organized, it was found that vast numbers of people began to be directly dependent on the forest. Apart from those employed in all the various works connected with the growing, the felling and the sawing of trees into timber, a host of people like timber merchants, workmen employed in sawmills, in building, in ship building, in carpentry, in coach building, in engineering, in turning, in carving, in paper pulp manufacture, in match making, in the manufacture of cases from the large packing case to the smallest toy box, in making drums and casks, pencils, instruments, tools, shovels, boot lasts, and in some countries even boots themselves, saddle trees, brushes, gun stocks, toys, and dozens of other things, were wholly dependent on forests. Before the last war it was calculated that about 12 per cent. of the whole population of Germany were directly or indirectly dependent for their livelihood on the work produced from forest material, and even in Great Britain, where State forestry was hardly known before the last war, there were still 3/4 million people dependent indirectly on forests for their livelihood. *It therefore became necessary that approximately the same quantity of timber should be put on the market yearly or there was bound to be unemployment.*

Now a forester in India may have anything from 300 to a 1,000 square miles of forest to control and, however skilled he may be at his silviculture, that is the general growing and tending of his crops of trees, he cannot possibly know that he is felling the right amount each year to continue for ever. Obviously such a thing cannot be left to chance and must be carefully calculated.

In addition to that, however, fairly obviously the amount that must be felled from a forest is the amount which the forest puts on in growth each year. If you fell too much you slowly decrease the amount of growing wood and, carried to an extreme, you would eventually ruin your forest. Practically all forests in the early days of forest utilisation suffered from over-felling. But it is equally obvious that you should not underfell your forest, otherwise you are not making the full and legitimate use of your forest capital.

Every single tree in the forest, from the tiny one-year-old seedling to the mature tree ready for felling, puts on a skin of growth every year. It is the addition of all these skins of growth on every one of the millions of trees of all sizes scattered over, as I said, perhaps 500 square miles of country, which the forester is entitled to fell. But it is impossible to go round with a razor and skin off each little bit of this

annual growth from each individual tree, and anyway it would be quite useless if you did. The timber from a tree is only useful after that tree has attained a certain size and, within reason, the bigger the tree, the more useful and more valuable is the timber from it.

The problem therefore is to translate the total of all the little bits of growth put on every tree, into terms of the largest trees only and then to fell during the year the exact number of large trees which represents the annual growth. This is a very nice little problem in mathematics.

The combination of all this gave rise to a further branch of forestry, namely the calculation of this annual yield, its method of felling and how the fellings are to be distributed. This is the branch of "Working Plans" or "Forest Management." A forester works entirely on a document called a working plan, which is simply an exact record of all these calculations, and is a document instructing him in general in all he has to do over a lengthy period of probably 10 or 15 years. Even that, however, is a very short time in the life of a tree because, unlike an agriculturist who sows his crop this year and reaps it in six months' time, the unfortunate forester sows it this year and it is reaped 150 years hence by his great-great-great-grand children.

The compiler of the working plan, though he gives details for 10 or 15 years, has, at the same time, to remember in his calculations that he is in fact working over a period of 150 years of whatever the rotation may be.

Lastly there is one more great branch of forestry. As forests increased in value, a further branch arose called "Forest Valuation" or "Forest Finance." Let me impress on you that finance in relation to forestry is a completely different thing from finance in relation to most other activities in this world. If you run a business and you put in money this year, you probably reap the product from that money at the end of a year or at most at the end of a few years. But the unfortunate forester, investing his money in forestry this year, has to keep it locked up in that particular crop for something like 150 years. Therefore the whole of his calculation of profits is based on compound interest on all items occurring at different intervals over 150 years and then the answer discounted down again to the present day.

If you can remember all these various branches of forestry, which I now propose to name in their logical order rather than in the order in which they actually arose, namely, Laws and Regulations, Silviculture, Working Plans or Management, Forest Finance, Forest Utilisation, with Forest Protection running right through both the Silviculture or growing side and the Utilisation or trade side, you will see that the training of a forester is not merely a training to cut down trees. Forestry itself is an applied science, or rather collection of sciences, and much of it in practice is an art rather than a science. But a competent forester must at any rate have a fairly advanced knowledge of:

Pure and Applied Mathematics.
Surveying.
Elements of General Law.

Political Economy.
Physics including Meteorology.
Chemistry both Organic and Inorganic including a knowledge of soils.
Mineralogy and Geology.
Zoology, especially Entomology.
Botany.

With a basis of these sciences he can then begin to learn forestry. The ordinary course of a forester is about three years taking a science degree, B.A. or B.Sc., which covers a certain number of the sciences necessary, and then two more years' special training in forestry, which, besides all branches of forestry, includes various sciences possibly not taken in his degree course.

And now I propose to end by telling you very briefly what Indian forests and forestry have done during the war.

A side issue of forestry is the research connected with it and here you have this Forest Research Institute. Out of its five branches only two are not solving problems directly concerned with the war and even those two, Botany and Silviculture, have been engaged on one or two direct problems and on a large number of problems indirectly. The other three, Entomology, Chemistry and Utilization, are doing practically nothing but war problems. The mass of timber required by the army is all liable to insect attack and owing to bad methods and the ignorance which prevailed at the beginning of this war, a very large number of depots were attacked and shipments arrived at their destination as dust and not timber. It has been estimated that the damage in depots from one family of insects alone, saved for 20 days, would run this hospital for a year. With care that damage can be reduced to one-fifth.

The Entomologist here is continually advising the Ordnance Department on how to protect its timber against the ravages of insects and, in addition, several forest officers have been taken from the forest service for whole time work with Ordnance. The Chemistry branch here looks after all the minor forest products. As a result of the work of that branch 95 per rcent. of the world trade in ephedrine has been captured and a factory for its manufacture has been erected in Madras. A plant has been installed for extracting creosote from pine wood, a material has been found for what is called creaming rubber latex, and another material for sizing textiles of which the military demand is enormous. All these supplies from outside India had entirely ceased owing to the war. I could name dozens of things produced from minor forest products in this way and directly connected with war, ranging from substitutes for rubber to wax for copying paper for typewriters—all from forest products.

The Utilisation branch by its very nature, is more directly concerned with war problems than any other branch. Apart from producing innumerable wooden articles as substitutes for metal and cases to pack Ordnance stores, it solved among dozens of other problems the very difficult one of producing enough boot lasts quickly to supply the enormous army demand for boots. The boot last problem, by the way, is not so simple as you might think. You cannot make a boot without

a last and a last has to be cut from a seasoned block of timber about 15 inches long by 5 in. by 5 in. Now to season such a block of timber in the ordinary way, even in a kiln, takes such a considerable time that most of the army would have had to fight the war bare footed if the problem had remained in that state. But it is quite easy and quick to season a $\frac{1}{2}$ in. plank. Ten half-inch planks 15 inches by 5 inches will quickly season and stuck together will give the same dimensions as a block of 15 inches by 5 in. by 5 in. The next step was to discover an adhesive to stick these ten seasoned planks together so firmly, that the resultant block could be treated like a solid block of wood. An ordinary glue would not do. This problem of an adhesive was also solved here and from local materials, and, incidentally, it is not only used for the planks of a boot last but has also passed the test and is used for aircraft and marine plywood. Out of the solid block of wood thus built up by these separate little planks, the boot last could be cut. The result is that the army march with boots instead of bare footed! Incidentally the same principle of seasoning planks and then sticking them together and cutting out whatever is wanted is used for aircraft propellers. The product is called laminated wood.

Perhaps the most recent and interesting thing that this branch has done is to make compregnated wood. Compregnated wood is made by taking thin veneers of wood, impregnating them with synthetic resin, then sticking them together and subjecting the whole to heat and pressure. This forms a material heavier and stronger than any natural wood. It is used for the hubs of certain air screws. Incidentally it is an open secret that the units of the R.A.F. making this compregnated wood and these laminated propellers are working under the technical advice given from this Institute. There is no time to tell you more of what the Institute has done on war problems and this is only the research side and is not of course the work of the ordinary forester.

The forest service throughout India has supplied an enormous amount of material for all the normal timber demands of the army in addition to all those rather specialised items which have been enumerated on the research side, the timber for which of course comes to an enormous quantity. It has supplied direct to the Defence Department about a million tons of timber a year for such things as hutting timber, bridge timber, piles for jetties, heavy building timber, lorry bodies, pontoon boats, etc. etc. It is difficult to convey to you what a million tons of timber means, but if it were placed end to end, it would easily make a track 4 ft. wide and $\frac{1}{2}$ in. thick round the world at the equator.

With this very brief outline of what general forestry means, I must close, but I hope that next time a man tells you he is a forester, you will not assume that he is merely a fellow who cuts down trees.

PROGRAMMES

BY C. E. HEWETSON, I.F.S.

As the subject of post-war planning in all branches of national and international activity is now fashionable in every country, I hope the *Indian Forester* will accept a brief article and not find it too commonplace. Mr. Garland made a contribution on an allied subject some months ago. In Mr. Garland's article the emphasis was on bringing back nature to the dwellers in cities and the highly cultivated agricultural districts; in this article I am more concerned with the very wild parts where the aboriginal tribes are in need of bringing in the benefits of civilization and progress.

The first question is what sort of financial and economic system will govern the post-war world. With the example of the U.S.S.R. before us, planned economy is now a panacea—though few people realise yet what sacrifices it entails from the private citizen. When it is found to involve the elimination of *zamindars, malguzars,* company promoters, industrial magnates, stock bank presidents, *banias* and the other vested interests of our present land-owning capitalist system, we may expect to hear the usual skilled propaganda and see the political manœuvrings of these "blood suckers" or "pillars of society", the term depending on one's political ideas. However, I will assume in this article that a reasonable amount of planning will be seen in post-war India, and that vested interests will be curbed if not eliminated altogether.

In any planned economy the agricultural and forest services come in on the ground floor or rather in the basement. They are both concerned with the basic process of utilising the culturable soil and the solar energy falling on the land area of India to produce the maximum quantity of useful products. In no part of the world with the exception of China is it more important that the very best use should be made of every acre of land. If it was only a question of allotting land to the best possible use, and growing the quotas of each product ordered by the planning authorities of the state, the agricultural and forest officers, given the money, could probably make shift to do this at a cost of wholesale eviction of cultivators, amalgamation of holdings, communal farms and ejection of aboriginals from the forests. How the Russians did it is no concern of ours, but I make my first point that the human factor must be taken into account.

The older type of administrator was inclined to think on arithmetical and humanistic lines. So many more hospitals, so many more schools, so many more roads, more soap, less alcohol, more leisure, less toil and the millenium would have arrived. We now know it is not so easy, and that too much of the ease of civilization is worse for the human being than too little. Particularly the rapidly growing work of the anthropologists, such as, to give examples from the Central Provinces, Mr. W. V. Grigson, I.C.S. and Mr. Verrier Elwin, has taught us how easily culture is disturbed or destroyed by sudden and ill-advised changes in the economic and social surroundings. It looks as if we will have to call in the anthropologist to help us in the basement. This indeed is a wise step. In these times we have two extremists of whom we must be equally beware; the planning enthusiast who will reduce

human society to the level of bees or white ants; and the pure *laissez-faire* economist who believes that the survival of the fittest is the surest key to future progress of the human race. At present the first is our most immediate danger, and in the company of the anthropologist we hope to be warned before we fall into his errors.

We are now ready to examine the position of the forests in a well-conducted state. I will not base the usefulness of forests on the production of an indispensable raw product. Every use for which timber is employed at present could be, and probably will be fulfilled by another article in the post-war industrial world. Concrete and steel in buildings, steel and plastics in furniture, and synthetic cellulose in fabrics, paper, etc. I am sure that by 1950 an enterprising chemist will have synthetised teak wood. These things are all possible, but in a well-balanced economy would they be allowed? From the many trees of India we can find timbers suited excellently well for all purposes. The growing, tending, conversion and sale of these timbers provides employment for large numbers of people in a way to which they are well accustomed. Is there any advantage in producing these articles in a factory-even if it can be done more cheaply in terms of human labour? Are we to move the aboriginal tribes and other forest workers to the manufacturing centres to work in the plants producing cellulose from the flu gases of the power stations? Or to leave them in the forests to tend the trees which convert the CO_2 of the atmosphere? This is where a planned economy has great opportunities. The steel manufacturers and organic chemists might propose to make everything of steel and synthetics, but the planning authorities of the state would keep them in their place. They would say we already have veiy good timbers and we intend that certain parts of houses, and furniture shall continue to be made of timber grown in our forests and you can keep your steel and plastics for the articles already allotted to you, and we do not require any more factories. In the same way the organic chemist may be offering to make all our food, and would promise to produce it much more cheaply and regularly than by the present laborious and rather uncertain methods of planting and tending food crops. I think that if the authorities are governed by the anthropologists they will say "We will continue to grow our food in the fields and our timber in the forests."

Having accepted the principle that the forests and the wood using industries are to be retained as a permanent part of the state economy, the authorities will issue a charter making clear the part to be played by the forest services and the owners of forests. The charter will specify—

(*i*) The purposes for which timber and wood products are to be used, and for which other substitutes may not be used.

(*ii*) The areas to be set aside in each unit permanently for forests and the production of timber. Also, the regulations to be framed so that the reserves are not overfelled, and their productive capacity is maintained. This would apply both to Government reserved forests, and to private forests.

(*iii*) The building up of a prudent reserve to enable the State to meet sudden emergencies.

(*iv*) The forests where required would be declared as the home of forest tribes and the reserve would be regarded not only as a place where timber is grown, but also as the living space of the aboriginal inhabitants.

(*v*) The provision of national parks for recreation and the enjoyment of city dwellers.

Having received their charter how should the forest services and forest owners be organised to fulfil the role entrusted to them?

To fulfil our task we require a three-fold programme, Research, Education and Organization. A whole article could be given to each of these subjects. Despite the steady work of our world-famous institute at Dehra Dun, we still have a great deal to learn and on many basic problems information is scarce or tentative. Any thinking forest officer could detail problems from his own division to which he would like answers. The few problems I give below are a sample and are selected to shew the scope for future research.

(*i*) We know very little about forest soils; there is no generally accepted classification. We do not know what site will give a good teak plantation. We do not know why teak and *sal* grow side by side, but practically never together.

(*ii*) Outside a few important trees very little is known about the silviculture of most of the Indian trees.

(*iii*) The seasoning, uses and treatment of many potentially useful species is imperfectly known.

(*iv*) There are no reliable statistics of timber utilization and the demand for wood products.

Research adequately organised and financed is the foundation. The central station at Dehra Dun must be backed up by provincial branches engaged on the peculiar prolems of their local forest types. Next, to work the charter and deliver the goods will require a highly educated and technically competent staff with well trained and efficient subordinate services in each province. The present colleges and provincial schools must be retained and improved, and the training carried down to the forest guards. Thirdly, a central forestry board will be required to decide how much each unit can produce, and what quotas and of what species the quotas should be made up. In order to answer such questions each unit must have regular working plans for all the area allotted to forestry both Government and private. This will entail a long overdue reform in bringing all private forests under control. It is not necessary to expropriate the owners, but the regular management would be secured as in parts of Europe.

So far we have regarded the forest as a factory, and the management on the most scientific lines to produce the quantities ordered by the State. We now have to consider the forests as the living space of certain tribes and in relation to the economic condition of the surrounding countryside. We cannot separate the forests off from man. We may have to adapt our management to the psychology of the people, remembering our first principle, that our land utilisation must keep the inhabitants happy and prosperous. In the policy to be adopted towards the aboriginal tribes we reach territory in dispute between the anthropologist and the reformer. Are they to be let alone in their ancestral beliefs, or to be accepted within the fold of some better organised religion, or just detribalised and thrown

in the melting pot? The decision will rest with the State and the forest officer will be required only to arrange his management in consonance with the decision reached.

The relation between the local inhabitants and the forest officer should be less conflicting than at present. The quantity of timber to be supplied yearly will be fixed within certain limits, and violent fluctuations will be avoided. The price will also be controlled and there should be a steady prosperity in the place of the present hardship. For instance the railways would undertake to use a proportion of wooden sleepers; road transport companies would have to use charcoal in their vehicles, and so on. With the public statement of the principle that the forests belong to the whole population, and not to the people who happen to live near or in the forest, there should be no excuse for the slogan that the forests have been stolen from their rightful owners; and with the recognition of the forests and the forest dwellers as part of the economic structure of the country, there will be no excuse for the town dwellers to spend all the public revenues in and about the towns, and the forest community will feel that they are getting a fair deal from the remainder.

Finally we have to consider how changes in management which demand changes in the habits or customs of the inhabitants are to be guided and controlled. These decisions will require careful consideration and consultation among agricultural, educational and administrational officers of government. The sort of question I have in mind is control of grazing or the right to lop trees. In parts the uncontrolled exercise of rights may ruin not only the forest but spread destruction to people at a distance. The correct solution will be without doubt that such people acting harmfully to the State as a whole must be curbed; in the same way as fraudulent company promoters, stock jobbers, and commodity speculators. The most hopeful part of a planned economy would be that the Government would have the moral courage to check abuses which are due to human acquisitiveness or laziness.

The third part to be played by the forests is to provide reserves organised on the lines of the national parks of the United States where the people of the cities may come to enjoy the "jungles" for which India is rightly world famous. And is it too much to hope that these visits may be arranged without the usual sequel of a go of fever?

Such in very brief outline is a programme for forests in an intelligently planned State.

SOIL EROSION CONTROL IN BIHAR

By W. D. M. Warren, I.F.S.

Of the two agencies causing erosion, wind and water, only the latter need concern us, in Bihar.

Gully Erosion.—Water erosion can be classified into two distinct types, gully erosion and sheet erosion. Both types may be found occurring together on the same area. Gully erosion however is particularly prevalent, where water collects in

slight folds on upland plateau areas, to pour off in concentrated form over the edges of deeply erodible soil often six feet or more in depth. The gullies thus formed may eat back into the top fertile soil at the rate of several yards a year.

Sheet Erosion.—Sheet erosion on the other hand is the result of the diffused action of water. It is usually found on the comparatively smooth slopes of hills where a thin soil barely covers the underlying partially weathered rock beneath. Where sheet erosion is severe, there may be no top soil at all except in pockets or folds in the hill side—erosion keeping pace with soil formation.

Both kinds of erosion, gully and sheet are the result of man's interference with Nature. Left to herself Nature clothes the plateaux and hillsides with a protective vegetative cover of trees, shrubs and grasses, all of which either separately or collectively, are effective in preventing soil losses. Man comes along, cuts down the trees and shrubs, while his attendant animals graze without restriction on the grass that lies beneath until no protective cover is left. The soil is then exposed to the full erosive action of torrential rains.

Few benefit.—Scarcely any one benefits by this washing away of upland fertile soil and sub-soil so badly needed *in situ*. Carried along by the strength of the current the soil is sifted into its separate elements. The coarse stones are deposited first along the stream bed, then the sand, and finally the silt, when the strength of the current now a broad river, has become sluggish.

Silt not an unmixed blessing.—Even though the silt may be highly valued for its fertilising qualities it is by no means an unmixed blessing, for it is rarely deposited on the level lands of the plains, except as the result of heavy floods causing devastation and distress. Thus the benefits may easily be outweighed by the damage of the floods.

Sand a curse.—The sand deposited while the current still runs comparatively swiftly is a curse, of benefit to no one. It chokes up the river channels causing floods and forcing rivers to change their course year by year. In this province in north east Bihar, large tracts of fertile lands have been laid waste by the vagaries of the river Koshi, whose general course lying north-south is gradually moving westwards, while the river Gogra in the extreme west, constantly threatens the countryside above Patna with floods. Heavy rains in the Damodar river which drains the Ranchi and Hazaribagh plateaux in Chota Nagpur, cause floods in the Midnapore district of Bengal.

Menace to Irrigation.—Silt carrying water is a constant source of worry to the irrigation engineer. If he permits too much silt into his irrigation channels they will choke up and become useless. To safeguard himself against such a calamity he must test the irrigation waters at the inlet from the rivers, daily, during the monsoon to find out what percentage of silt is being carried. If the silt rises beyond the danger point, the irrigation inlet gates are closed and the river waters shut off. Thus ryots are deprived of a considerable portion of the volume of rivers for this reason, water which if it could be kept free of silt and sand, would be most valuable to them. The Sone river waters in this province during times of heavy spate, when the silt carried is high, have to be excluded in this way, while in the Punjab the heavy silt carrying Chenab has had to be excluded altogether from the irrigation

system. We see then that erosion benefits few people and even with those few, the damage done by accompanying floods often greatly exceeds the benefits conferred. The upland cultivator loses soil he can ill spare and the ryot dependent on irrigation for his prosperity loses water he would gladly have but for its silt content.

The remedy.—As has already been stated Nature if left to herself spreads over her uplands and hills a vegetative cover which is very effective against erosion and soil losses. The task then is to restore the balance of Nature by restricting man and his grazing animals' activities sufficiently to enable Nature to rebuild that protective cover. All forests on hill slopes should therefore be brought under strict control for fellings while grazing should be strictly prohibited during the monsoon rains. To achieve this end it will be necessary perhaps in some cases where the grazing incidence is heavy and restriction is difficult, to transport whole villages from catchment areas to other places, where their agrarian activities can be carried on with less danger to the public weal. This may seem a harsh expedient but the tranquillity of the few must be sacrificed for the good of the many. Only where other agricultural lands are not available for resettlement, should alternative methods of control be considered. For the alternative methods are expensive to operate and depend for their success very largely on the efficiency of the supervising staff. Unfortunately also, the staff will meet with passive resistance from the villagers—the greater the incidence of grazing the greater will be that resistance.

Alternative methods.—The alternative methods to strict prohibition are (1) to permit grass cutting only during the rains for the stall feeding of cattle, while insisting that the villagers leave behind a 4-inch stubble. This is perhaps the better alternative (2) Rotational grazing with the proviso that no area shall be grazed for more than one month in three during the monsoon period June-September is another method. Care must be taken to see that the number of cattle grazed is resricted to the maximum number the area can sustain without detriment to the grass cover. And each and every area should be allowed to seed itself naturally every three or four years to thicken up the sword.

Better yields from prohibition.—Restriction or prohibition of grazing during the monsoon on sloping land results in a better yield, giving the grass a chance to grow to full development before harvesting. In the Punjab a ten acre village area badly eroded from heavy grazing, and which showed no sign of improvement despite the exhortations of the local forest staff was fenced against grazing. The first year's yield after fencing gave only six maunds of grass, so heavily had the grass cover been depleted, but in the third year the yield was eighty maunds and now by utilising by means of contour trenches the waste waters from above which were tumbling off the area in a series of waterfalls, the yield per acre is more than thirty maunds and all erosion has long since ceased. Once the villager realises that grazing restriction increases the grass yield he will then more willingly co-operate.

Trenching an anti-erosion aid.—Contour trenching above the gullies by spreading out the concentrated waters causing gully erosion, is an effective antidote to this evil. It is really wonderful how a simple little trench 2′ × 1′ in cross section constructed in this way can effectively arrest this eating back of the gully. Trenching used in conjunction with closure to grazing can re-clothe devastated badly sheet

eroded hillsides with a grass cover in the course of a few years only—five years in the case of one extremely bad area in Khurchutta, Hazaribagh district, Bihar.

Co-operation among Provinces necessary.—Unfortunately effective erosion and flood control in Bihar depends to large extent on active co-operation among neighbouring provinces and states. Thus while the upper catchment area of the Sone river can be brought under complete control in this province, the upper catchments of the Kosi and the Gogra depend upon the goodwill and co-operation of Nepal and the United Provinces respectively. Equally Bengal looks to us hopefully to control the upper waters of the Damodar river.

Provincial successes.—Steps are already being taken to control the Damodar river, by inducing local *zamindars* to hand over their forests to us for management but the process is necessarily a slow one as we have no powers to compel them to come in.

Attempts at re-afforestating eroded areas are already being made as already mentioned, in the Khurchutta range, near Giridih, by closure to grazing, broadcast sowing of grass seeds and *Boga medeloa,* contour trenching, and finally the introduction of tree plants once the vegetative cover has become established. The technique varies with the nature, and degree of erosion met with, each area having its own problems to solve.

However a fair measure of success is already being obtained. As confidence grows, the successful methods will doubtless be utilised in other areas especially in the *zamindary* forests now being taken over. But a large and heavy uphill task lies before us and even if the present policy is pursued with vigour, it will be years before we can say that we are masters of the situation.

STERILIZATION OF SOIL

By Sardar Baxis Singh, D.D.R. (Medalist)
Late Conservator of Forests, Patiala State
(*Now Forest Officer, Alirajpur State, Central India*).

In Orissa *malies* in summer stock soil for use in pots to raise cauliflower and cabbage seedlings. They would collect this soil from dry beds of tanks. I used to follow my own way of mixing leaf mould, sand and garden earth, but would find my crop suffer in so many ways specially from attacks of earthworms and ground pests. I told this all to a *mali* and he explained the reason as to why they collected dry earth from tank beds in summer. The earth so kept, he told me, was immune from earthworms and soil pests. I grasped his point and improved on my method by putting my earth in big *handies* and heating it to a very high temperature, so as to sterilize it fully. The earth obtained by this method when used in pots and kept carefully away from the ground contagion gave far better results and I now always adopt this method in raising plants from tiny seeds and I get very satisfactory results.

EXTRACTS

AS RUBBER GOES

When Japan started her drive into the rubber-growing areas of the Far East, she dealt a blow to the rubber industry of the United States, creating a serious shortage of crude rubber. With the industry rapidly gearing itself to war-time production, this blow seemed, for the moment, to be the end, to be the one thing that could mean the difference between final victory and defeat. Rubber was vital to many war machines. Without rubber, we were licked before we really got started.

But as time went on and opportunity presented itself to take stock of the situation, there came the realisation to many that the blow was really to be considered as an aid to the United States in more ways than one. Regardless of how the factors of speed may be viewed, often in the light of political leanings, a synthetic rubber industry sprang from the laboratories of the United States.

Although it is not possible to make direct statements as to synthetic rubber production at present or in the immediate future, it is an open secret that plants now being constructed will have sufficient capacity to more than fill the country's requirements of to-day and many tomorrows. What will be the base from which it is made is still a question, although the petroleum advocates appear to have most of the

convincing arguments on their side. This in spite of dwindling petroleum reserves, since it has been established that to make sufficient *butadiene* to produce 800,000 tons of rubber a year (our largest annual consumption in pre-war days was 765,000 tons) would demand only some 2 per cent. of our largest peace-time production of petroleum.

Synthetic rubber is even now meeting the tests on the toughest proving grounds in the world war. It is, of course, being tested in tires and, reports have it, is showing up remarkably well. Then it must be remembered that synthetic rubber has many desirable qualities not found in natural rubber. Among these are resistance to the attacks of gasoline, oils, and other solvents of natural rubber, better aging characteristics under adverse conditions, greater adaptability during manufacture to definite ends, and so on.

From all this it becomes apparent that synthetic rubber has an unlimited future, if other factors do not interfere too much. For example, there is the question of what will happen to the synthetic rubber industry when natural rubber once more becomes available. Tariffs may be erected to protect the industry if, by that time, the price of synthetic has not been reduced sufficiently to make it a direct competitor of natural. Or it may work out that the Far East will be so badly in need of re-established markets that natural rubber will reappear in the United States, while the synthetic industry will receive the artificial respiration of subsidy, again assuming that a price differential exists.

However, the financial angle works out, it is now certain that synthetic will find substantial post-war markets, whether alone or in combination with the natural product. Already the laboratories are working on the problem of adapting existing—but frozen—markets to synthetic rubber for after-the-war operations. At the same time, new markets are being developed.

Itemizing a few of the known possible uses of synthetic will point the way sufficiently to indicate the enormous markets which the material can command in days to come: Rubber springs for vehicles, with all the obvious advantages over metals; long conveyor belts for use on huge construction projects, speeding up work and reducing labour requirements; rubber containers and container linings for transporting liquids; water pipes that will stretch when frozen but will not break; women's hose that will have astonishing wearing qualities; tubeless tires—the list could be extended indefinitely to include uses that will affect the daily lives of every man-in-the-street.—*Scientific American,* June, 1943.

WHAT IS LATERITE?

BY J. H. MACKAY

Soil is produced by the weathering of rock which becomes disintegrated and decomposed under the influence of climatic and chemical action. It consists partly of unchanged fragments of rock-stones, gravel, sand and silt—and partly of products of chemical decomposition which are mainly in the form of clay. Where vegetation is present, organic matter is added to the soil in the form of humus.

The chemical constituents depend primarily on the nature of the rock from which the soil is derived, and this of course is not always the underlying rock; some soils are alluvial, others wind-borne. Rocks are mixtures of minerals, usually in crystalline form, the simplest of which is quartz (silica or silicon dioxide) which normally forms much of the gravel, sand, and silt of the soil. Larger quantities of silicon dioxide occur in rocks as silicates in combination with the oxides of metals, particularly aluminium, iron, magnesium, calcium, sodium and potassium. Felspars, the most abundant of the minerals, are compounds of aluminium and other silicates. Black mica is somewhat similar in composition but contains iron. Hornblende augite and olivine, also important minerals, are mixed silicates containing principally magnesium and iron.

The normal minerals are all insoluble in pure water. Rainwater, however, absorbs carbon dioxide from the air and becomes weakly acid, and under its action, assisted by physical factors, the majority of the rock minerals undergo decomposition. Simple compounds of potassium, sodium, calcium and magnesium as well as phosphorus, sulphur and most other minor plant-nutrient elements are dissolved out. Some iron, but only a trace of aluminium, dissolves while quartz remains practically unchanged. The solution containing the available plant-nutrient elements, formed in the zone of weathering, may percolate away or diffuse through the soil water, but it is normally concentrated near the surface of the soil as a result of the pumping action of plant roots. The erosion of a few inches of soil from the surface may therefore ruin fertility.

The silicates eventually leave an almost insoluble residue of clay. The clay fraction of the soil is a mixture of oxides of silicon, alminium and iron, and water, firmly combined in certain proportions. The iron is normally in the ferric state (Fe_2O_3) while aluminium only has the one oxide Al_2O_3, and these are referred to for convenience as "sesquioxides." The clay minerals are resistant to further attack by weathering agents, but under conditions of high temperature and heavy rainfall they gradually break down into the constituent hydrated oxides; the silica is more soluble than the sesquioxides, unless the soil water is acid, and tends to be leached away leaving a preponderance of sesquioxides.

The nature and degree of leaching depend upon the general conditions under which the soil is formed, the amount and distribution of rainfall and soil water, temperature and plantcover. In humid temperate regions where there is a large accumulation of humus, derived from decaying vegetation, and consequently humic acid in the soil, it is the sesquioxides that tend to be leached away leaving a preponderance of silica, which sometimes forms a hard impenetrable layer of "pan" below the soil surface.

In the tropics under the relatively open savanna woodland conditions a considerable amount of organic matter may be produced but comparatively little humus accumulates in the soil as decomposition is rapid. The humic acid is oxidised almost as soon as it is formed and silica leaching is predominant leaving an accumulation of sesquioxides. In the soils of tropical forest, owing to the very large quantity of organic matter falling on the soil each year, some humus is incorporated in the soil and may result in partial leaching of sesquioxides from the surface of the soil, but the other process, leaching of silica, predominates.[1]

The properties of clay are closely related to the proportion of silica to sesquioxides in its composition—the "silica-sesquioxides ratio," or the ratio of the number of molecules of silica to the number of molecules of the sesquioxides. In unchanged felspars this ratio is about 6, but on decomposition, with loss of soluble silicates, clay minerals the ratio of 4 or less are produced; in the commonest clay minerals the ratio is about 2. Many tropical soils however have values well below 2 for this ratio and soil scientists use the terms 'laterite' and 'lateritic' to describe such soils; the process of silica leaching is referred to as 'laterization.' These types of lateritic soils, with a low silica-sesquioxide ratio, have distinctive physical properties. The clay is much less sticky when wet than that of more normal soils, and such soils, even although containing little sand, behave as light loams under cultivation. There may be no suggestion of consolidation into 'ironstone' or pebbly concretions.

But this is not what the ordinary person means by laterite. To him laterite is a hard, rock-like concretionary mass or crust of ironstone and to avoid confusion of terms it would be preferable to use the term 'allitic' to describe the other types.

How, then, are these laterite concretions formed in tropical soils? It is probable that the process of laterite formation varies under different conditions and there are several types of laterite, but the main factor is the precipitation of iron oxide (and sometimes magnesium oxide), by oxidation from contact with air in the soil. This forms deposits in the interspaces of the soil particles, producing in some cases pebbly concretions, in others thick sheets of consolidated, brick-like material. The concretionary layer becomes very hard on exposure and the term 'laterite' is well suited to this. The soil has, in effect, been reconverted to rock although quite different from the rock from which it was formed and one should not call it rock. It is in this sense that the term is used in the article by Brymor Jones[2] (Lateritic Ironstone in Sokoto Province) in this issue of *Farm and Forest*. It is considered that laterite in Nigeria is mainly formed by a process of illuviation whereby sesquioxides released during weathering are carried upwards in solution and deposited during the dry season by oxidation and evaporation.

Pendleton[3] describes the formation of laterite in Thailand and Cambodia as due to the oxidation and precipitation of iron compounds, carried down by percolating rain water, in the zone through which the upper surface of the ground water fluctuates annually. This layer of soil, developed and hardened by oxidation and precipitation of iron compounds is laterite and he considers that it cannot develop except in the zone within which the ground water surface fluctuates, so that presence of ground water is essential. The iron compounds in such a

zone in the subsoil will precipitate around and between whatever other insoluble materials occur, quartz, sand, pebbles, and clay and other aluminium compounds, and may commonly have a cellular, slag-like structure.

Doyne and Watson[4] have described the presence of concretionary layers in the Ilepa Soil Type in Southern Nigeria, at depths varying from the surface itself to about 3 feet. This layer often develops into a hard, cemented conglomerate forming an impermeable pan. There is generally a large proportion of quartz which may have formed nuclei for concretions. Below this laterite layer is zone of red clay which becomes increasingly mottled with white as the rotting rock is approached. The clay shows the original rock structure but the laterite does not. The writers suggest that of the products of the disintegration of the rock, quartz probably tends to collect towards the top of the disintegrating mass owing to washing down of the finer material. During the dry period the soluble salts rise from the rock and liberate free acid which causes the iron to become mobile. The mobile iron will rise leaving the lower horizons mottled and finally bleached but as acidity decreases in the upper layers it becomes less mobile and iron is deposited round the quartz particles, dries, and forms the concretionary layer which may develop into a hard pan. The soil above is rarely red and it may be due to secondary weathering of the concretionary layer or it may be detritus from elsewhere.

Vines,[5] however, regards the Ilepa soils from a different point of view. In his decription of the soil catena of this type he considers that the concretionary-ironstone layer is formed at the level where seepage accumulates in the wet season *i.e.* in the zone where the ground water fluctuates (*cf.* Pendleton).

It is uncertain exactly what role humus plays in the formation of laterite. It appears to play an important part in determining the proportion of silica and sesquioxides retained by the soil. Lack of humic acid appears to encourage the formation of "allitic" soils but has this any relation to the formation of concretionary laterite? Surely the accumulation of sesquioxides paves the way and should the climatic and soil conditions be favourable to the deposition of iron oxide then laterization will rapidly cause.

Davis[6] considers that the silica leaching stage is a preliminary to the formation of true 'matured' laterite. In perpetually moist zones the 'allitic' soil remains but, he writes, "in localities with a very moist wet season followed by a dry season, solutions rich in sesquioxides are drawn upwards in the dry season causing an accumulation zone rich in Fe_2O_3 near the surface. These, specially under forest, may be nothing more than plastic siallitic laterites with high clay fractions. The humus, when present, as it is in good natural forest, also seems to serve as a 'protective' colloid to the sesquioxides, keeping them in solution. But if the humus soil is removed and the sesquioxides (chiefly of iron) reach the surface, they precipitate and form a hard ferruginious crust and the soil is transformed into dead rock which is inimical to any form of vegetation. The gravelly laterite which is so commonly come across seems to be a penultimate stage in the concretionary accumulation process. The impression I have gained by observation is that the penultimate and final stages in the process of laterite ironstone formation may occur with comparative

rapidity." If his general theory, attributed to Harrassowetz, is correct, the retention of all possible vegetational cover is of the greatest importance, and humus is of vital significance. It has been observed in Nigeria that exposures of laterite frequently occur near old village sites in forest country and are probably quite a good indication of former habitation and forest clearance. In open savanna regions laterization is generally much more intense and widespread and, as it encourages rapid erosion of the overlying soil, large areas of laterite may quickly become exposed on the surface, leaving a barren land, thinly clad in scrub and annual grasses, that one despairs of ever bringing back to cultivation.

There is obviously a very great deal to be learnt about laterization and it urgently demands study, being fundamental to the sound planning of land use in the tropics. The precise factors that produce laterization are only partially understood. The actual occurrence and distribution of laterite are only vaguely known. Only in extreme cases, where it is exposed on the surface of the ground by erosion, is its presence apparent. At one period nearly all the red earth were loosely called laterite; later it was considered to be relatively restricted; but there is no doubt that it has a wide occurrence in West Africa and is liable to become much more widespread if the loss of organic and inorganic colloids in the soil by clearance of vegetation and by leaching is an important factor in its formation.

How quickly does it form? Can the process be halted? What special precautions should be taken in cultivating land that is liable to form laterite when forest land is cleared for agriculture, or where laterization is already in process below the covering top soil? Can laterization be reversed or laterite broken down to cultivable soil by practical means? Or must we hope that the remaining surface soil will quickly be washed away so that a process of weathering may break down this rocky crust? But even then the process would go on and laterite reform, as it does now among the weathered fragments, unless some means can be found to check it.

All stages of the process have to be considered. In its earlier stage it does seem possible that laterization may be checked and reversed. Rosevear[7] has described how an allegedly lateritic soil at Enugu, that had been put under a plantation of teak, appeared after 16 years to have recovered and lost all trace of concretions. (This may be a leached lateritic soil due to the subsequent accumulation of humus and humic acid causing the iron and alumimium hydroxides to be removed and carried down from the surface, leaving a greyish quartzose top soil). If these changes are rapid, whether the laterizing process or the reverse, it is probable that there exists a good deal of local knowledge among farmers who must have observed such changes going on or have learnt about them from their forebears. It would be of the greatest value to collect such information. It may often be found unreliable but by sifting the evidence acquired from many different sources very positive results may be obtained.

Scaetta,[8] who has made study of laterization in Central and West Africa, suggests that there is a cycle in the evolution of tropical soils, that the hard laterite crust is the climax of soil evolution, but that it admits percolating water that weathers the underlying rock, forming a subsoil beneath which will form a new soil when the laterite crust has been removed by erosion. And the cycle continues, the new soil

being now exposed to laterization and in time forming again a hard inert surface crust. He suggests that this cycle is relatively rapid in tropical climates but points out that the precise character of the soil's evolution depends on topography, climate, vegetation and other factors.

As a result of his recent investigations Scaetta believed there was promise of finding an effective means of controlling laterization. While determining its climatic limits in 1937—39 he travelled widely over the southern border of the Sahara. He established that the layer of lateritic concretions in the sub-equatorial zone of West Africa, lay between 50 and 300 cms. below the surface; above, the superficial soil may bear a savanna woodland of trees with widely-spreading roots. The zone extends from 8 degrees to 16 degrees North. From 10 degrees to 14 degrees North the region is characterized by vast table lands of hard laterite, sometimes covered with a thin eluvium supporting degraded woodland, but grasses flourish where any soil has accumulated. Beyond 16 degrees North laterite is not found.

Scaetta considers that the laterization process in the sub-equatorial zone is slowed down in wooded areas by three factors. The decomposing organic waste from the woodlands sustains an active micro-flora and furnishes bases to the soil. The woodland catches the dust carried from the interior, especially in seasons when there is a low mist. This dust becomes incorporated in the soil, thus mineralizing it. And, thirdly, superficial run-off of rain and soil water is retarded by the woodland. The second factor, the mineralizing of soil by blown dust, is novel and of particular interest. Scaetta believes that the Guinea forest is maintained as a result of dust and sand carried from the southern Sahara; mainly by means of vegetal cover the mineral elements are added to the soil and counteract laterization. There is a state of delicate balance; cutting down the tall trees is sufficient to provoke a rise of the concretionary layer towards the surface. It seems necessary to maintain a vegetal cover capable of retaining a sufficient depth of soil and of forming or aiding in the formation of the humic-clay colloids that preserve the balance, which, once upset, can no longer prevent the formation of sterile laterite. So he considers that there may be even more wisdom than was thought in the native system of shifting cultivation, permitting a periodical fallow under forest.

Can an agricultural technique be found that will arrest the rise of this ferro-allitic layer? Scaetta observed that it was arrested by the presence at a slight depth, of decomposing parent rock material which serves to mineralize the soil as does the incorporation of dust, and thus can laterization be halted. Scaetta suggests that the same results may be brought about by artificial mineralization of the soil by introducing decomposing rock to soils that are in danger. This may be practicable under certain circumstances but most of us have probably still to be convinced of its efficacy. If organic matter also serves to prevent laterization the importance of humus deserves more attention and it is generally more practicable to correct the humus content of the soil than the mineral content.

Obviously the soil has to be given far more thought than hitherto and much research and inquiry must be carried out; it offers a most fascinating study. As

the demands on the soil increase with an expanding population striving to attain higher standards of living it is essential that fuller and wiser use must be made of the soil. In some regions it may be necessary to develop intensive agriculture by a system of composting. Other areas may best be 'recovered' by a prolonged rest under forest cover. The problem is most complex and cures may be many and varied depending on the natural and economic factors of each locality, but it demands urgent study and must form an important part of our post-war policy for the development of Colonial dependencies. Like every other major problem it must be tackled by a team of research workers, its practical solution does not depend on the soil scientist alone. It is one part of the much larger land conservation and development project and must be examined from many angles.

REFERENCES

1. Soil, vegetation and climate, Imp. Bur. Soil Sc. T. C. No. 29, 1934. Laterite and laterite soils. Imp. Bur. Soil Sc. T. C. No. 24, 1932.
2. Brynmor Jones. Lateritic ironstone in Sokoto Province, *Farm and Forest*, Vol. 4, No. 1.
3. Pendleton, R. L. Laterite and its structural uses in Thailand and Cambodia, Geog. Rev., Vol. 31, pp. 177—202, 1941.
4. Doyne and Watson, The Ilepa soil type, Journ. Agri. Sc. Vol. 23, p. 208, 1933.
5. Vine, H. A Soil Catena in the Nigerian cocoa belt. *Farm and Forest*, Vol. 2, No. 3, p. 137.
6. Davis, P. W. Teak and Nilambur Soils. The *Indian Forester*, Vol. LXVI, No. 2, 1940.
7. Rosevear, R. D. Soil changes in Enugu plantations. *Farm and Forest*, Vol. 3, No. 1, 1942.
8. Scaetta H. Reviews of various papers (Geog. Rev. April, 1942; and extracts from Soils and Fertilizers).

CONTROL OF DAMPING-OFF

The collapse of seedlings, usually on account of fungus attack, is called damping-off. While the subject is technically of prime importance to students of applied mycology, damping-off is serious in many forest nurseries and plantations, affecting seedlings of *Acacia arabica, Cedrela toona, Pinus longifolia, Soymida febfifuga, Terminalia tomentosa*, etc., and the methods dealing with the control of the pathogen are of value to all engaged, in India, in raising seedlings for artificial regeneration or afforestation purposes. The following excerpts from the scientific newsletters issued by the United States office of war information, give results of recent American research in this field.—*Ed.*

The Louisiana Agricultural Experiment Station in Bulletin No. 349 of June, 1942, embodying the studies over a seven year period in Sharkey and Olivier soils of the state on the treatment of seed and soil for the control of damping-off say:

"Red copper oxide when used to treat the seed proved the most practical and effective material to control damping-off of tomatoes and bell peppers, but failed to control post-emergence damping-off of eggplants. Vasco 4 and zinc oxide gave the best results with cabbages, red copper oxide being toxic to this crop. The commercial formaldehyde dusts when used to treat the soil were about as efficient as red copper oxide on the seed with tomatoes and bell peppers, but were of little value with eggplants. Zinc oxide, Vasco 4, and yellow copper oxide when used to treat the soil surface were about equally effective in controlling post-emergence damping-off of eggplants. Concentrated formaldehyde solution (40 per cent. formaldehyde) diluted in 5—6 times its volume of water was effective against damping-off

of tomatoes, peppers, and eggplants, but was toxic to eggplants in the Olivier soil. With seeds of ornamental plants, yellow copper oxide proved most efficient followed by red copper oxide, Vasco 4, and zinc oxide in the order named. The organic mercury dusts were often toxic when applied full strength."

The Pennsylvanian bulletin No. 434 of December, 1942, gives the results of experimental control of damping-off in tomato seedlings transplanted from sand and also discusses the effect of the immediate application of fungicidal drenches. The observations are:

"No significant evidence was found that lack of balance or omission of certain nutrient elements affects the susceptibility of tomato seedlings to damping-off in sand cultures, or that there are differences between properly-grown seedlings in sand culture *versus* steamed soil after transplanting to infested soil. However, overconcentration of nutrient salts resulting in chemical injury increased susceptibility. Washing the sand in hot water is thus essential for each seedling crop to remove excess soluble salts and organic matter as well as to destroy fungi. Reduction of the moisture in seed flats did not appreciably affect resistance if seedlings were transplanted soon after emergence. Extra K_2SO_4 slightly increased resistance, but a high moisture level was required to avoid chemical injury. After transplanting, seedlings were highly susceptible to *Pythium ultimum* for about three days and to *Rhizoctonia solani* for a much longer or an indefinite period. Thorough drying of Pythium-infested soil largely prevented damping off of transplanted seedlings, as their highly susceptible period was passed before sufficient mycelial development for attack. Environal factors favouring prompt renewal of turgor and growth reduced infection. Under conditions of moderate disease, reducing losses by about half proved possible through the use of sand or steamed soil as compared with untreated soil, but in averting severe losses, prevention of conditions favouring development of the pathogens in the transplanting soil is far more important than resistance or source of seedlings. In the absence of other preventive measures, safe and effective control in transplanted seedlings proved possible through applying comparatively weak drenches of $CuSO_4$, Semesan, or Spergon to prepared flats of soil just before or after transplanting."

The New Jersey's *Nursery Diseases Notes* of November, 1942, recommend the use of sphagnum to control damping-off as it is cheap, more pleasant to use, and will help the consersation of fungicidal chemicals for war purposes. A layer of sphagnum in seed flats and coldframes in many cases give more effectual disease control as shown by the experience of florists and nurserymen and by observations of Mr. P. P. Pirone, the author of the notes. He adds that:

"Seedlings grown in a layer of sphagnum can be transplanted with much less damage to their roots than those grown in chemically or heat-treated soil. Either fresh or baled sphagnum is prepared for use by rubbing through a sieve of hardware cloth of three meshes to the inch. Seed flats are filled to $1\frac{1}{2}$ inches of the top with soil or a mixture of soil and sand or sand and peat, and the remaining space of $1\frac{1}{2}$ inches in the flat is then filled with the loose, shredded sphagnum and wetted thoroughly either before or immediately after sowing, with a second watering a few hours later if needed. Stronger seedlings were obtained when the initial water contained a teaspoonful each of potassium nitrate and commercial superphosphate per gallon."

VOLUME LXIX 457 NUMBER 12

INDIAN FORESTER

DECEMBER, 1943

NOTE ON THE WORK OF THE FOREST DEVELOPMENT DIVISION, UNITED PROVINCES

By D. Davis, I.F.S.

Conservator of Forests, Working Plans Circle, U.P.

In the *Indian Forester* for July, 1940, there appeared an article by Mr. S. S. Negi on forest development work in the United Provinces. The following note includes for convenience some of the information given in the previous article and summarises the progress of this work to date.

In 1937 it was decided by the United Provinces government that part of the rural development activities should be the creation of village plantations and better utilisation of the waste lands in the plains of the United Provinces. A forest officer was put on special duty in December 1937 to investigate possibilities and early in 1938 the forest development division was created with an officer of the forest department in charge. Work was to be carried out in close collaboration with the rural development department. The activities of the division were to be the following:

(*i*) The creation of small village plantations for the production of timber fuel and fodder, chiefly on culturable land by means of *taungya*.

(*ii*) The utilisation of suitable waste land for planting up trees, including canal banks, roadsides, etc.

(*iii*) Increasing fodder production on village grazing grounds and fuel production in village scrub jungle.

(*iv*) Checking of erosion by protection of natural vegetation and by small bunds where necessary.

The main object of this work was to improve conditions for the villagers by

(*i*) providing fuel to replace some of the cowdung which is at present burnt and so to release some of it for manuring their fields;

(*ii*) providing small timber for houses and agricultural implements;

(*iii*) improving the grazing for their cattle;

(*iv*) checking the widespread erosion, which not only increases the intensity of floods, but causes deterioration of cultivated lands and grazing grounds.

The basic idea for the accomplishment of these aims was that the actual work was to be done by the villagers and *zamindars* themselves, the staff of the forest development division with the help and co-operation of the rural development department carrying out propaganda, supervising the work, supplying free tree seeds

and plants, and giving technical advice and help to the people in raising forest plantations, improvement of village grazing grounds and protection of ravine land.

Work on the above lines was started in 1938 in 7 districts in Meerut, Rohilkhand and Lucknow civil divisions, and plantations were started in a few areas in each district in the rains of 1938. In this first year the areas taken up all belonged to zamindars and efforts to persuade tenant cultivators to give up part of their land for plantations were not successful. In 1939 work was extended to 10 districts including Partabgarh in Fyzabad civil division, and plantations were formed over a much larger area, nearly a third of which consisted of small plots belonging to tenant cultivators.

Meanwhile demonstration plots were taken up for the improvement of grass in *usar* areas and for checking erosion in ravine lands. It has so far proved very difficult to make much progress in this type of work. The co-operation of the villagers is essential, but they generally refuse to co-operate. The formation of village *panchayats* for the management of such areas, so that the villagers themselves will take an interest in the work, seems the best solution. But practically all waste land belongs to *zamindars,* who generally refuse to allow management by *panchayats.* To ensure success on these lines it seems, therefore, that it will be necessary, at any rate to start with, for land to be acquired by government so that *panchayats* can be started without interference by *zamindars.*

Thus the main work of the division has been the formation of village plantations, and during the last 3 years work has been carried on in 11 districts in the same four civil divisions, viz., Muzaffarnagar, Meerut, Bulandshahr, Bareilly, Bijnor, Budaun, Moradabad, Pilibhit, Sitapur, Lucknow and Partabgarh, and is being started in Shahjahanpur this year and Rai Bareli next year.

The following statements show the areas taken up during the first 5 years, the figures for 1941 and 1942 under areas failed and successful not being final, as further attempts will be made to re-sow some of the failed areas, and some of the areas shown as successful may actually fail in the end.

Year	AREAS IN ACRES		
	Originally taken up.	*Finally failed.*	*Finally successful.*
1938	137	26	111
1939	628	208	420
1940	1,039	339	700
1941	2,427	478	1,949
1942	783	113	670
Total	5,014	1,164	3,850

The total for the five years is distributed as follows between tenants and *zamindars* and between land which was previously under cultivation and waste land.

	Tenants.			Zamindars			Grand total.
	Cultivated.	Waste.	Total	Cultivated.	Waste.	Total.	
Taken up ..	636	235	871	782	3,361	4,143	5,014
Failed ..	363	73	436	205	523	728	1,164
Successful ..	273	162	435	577	2,838	3,415	3,850

The above figures show how difficult it has so far proved to get small village tenant cultivators to take up this work. They have not much waste land and they do not really like giving up their cultivable land, especially just at present when efforts are being made to get them to grow as much food as possible. Hence the large proportion of tenants' land shown as failed under "cultivated." Much of this did not really fail, but was given up by the villagers and put under crops again.

The total area under successful plantations may not seem large for 5 years' work, but it represents over 1,000 different plots scattered over hundreds of villages. Furthermore, there have been many difficulties to contend with. In addition to the above mentioned difficulty in persuading tenant cultivators to give up land for plantations, the rains of 1939, 1940 and 1941 were particularly unfavourable for plantation work, and the fact that many of the plantations failed or were not very successful discouraged the villagers from offering as much new land as they might otherwise have done. Another unfavourable factor has been the war, which caused shortage of staff and funds, and the work could not be expanded as originally intended. It was hoped that it would be possible to expand the scheme gradually so as to cover most, if not all, of the 45 districts in the plains. It was originally intended that a new unit or division should be formed in 1941-42, and further units every three years until the whole province was covered. If the work of these forest development divisions is confined largely to village plantations, it is probable that 4 or 5 divisions would be sufficient. But if they are also to carry out additional work on a large scale, such as schemes for grazing control in waste lands unfit for tree growth, and work to check erosion and floods, improve fodder resources and generally to bring about better land management, it would probably be necessary to have at least 9 or 10 units or divisions, or one for each civil division.

But in spite of the fact that the war has prevented further expansion of this work, a very useful beginning has been made and much experience has been gained. The successful plantations have developed satisfactorily and many of them are already yielding fair quantities of fuel from thinnings. The progress so far made has been the result of much hard work and ceaseless propaganda on the part of the divisional forest officer and his executive staff of over 50 deputy rangers, foresters and forest guards. They are kept very busy throughout the year, the chief time for propaganda being the winter, and then in the spring they have to see that soil

preparation is carried out in the new areas to be planted up in the following rains, and during the rains constant supervision is necessary to see that new plantations are properly formed and old plantations tended. There is much other work to be done as well, such as seed collection for new sowings, work in nurseries, and supervision of thinnings and other tending operations in old plantations. One great difficulty at present experienced by the divisional forest officer and his two deputy rangers is the result of the scattered nature of the work, which extends from Muzaffarnagar in the north-west of the province to Partabgarh in the south-east, a distance of about 400 miles. The greater concentration of work in each unit, which will result when further units can be formed, will be a great advantage.

The chief tree species introduced in these village plantations have been *babul* (*Acacia arabica*) and *sissu* (*Dalbergia sissoo*), but many other species have been put in in varying quantities, *e.g.*, *khair* (*Acacia catechu*), *nim* (*Azadirachta indica*), *jamun* (*Eugenia jambolana*) and many others.

WORK DONE IN 1911 TO 1913 BY THE PUNJAB FOREST DEPARTMENT ON *CRYPTOSTEGIA GRANDIFLORA*

By I. D. Mohendru

(Divisional Forest Officer, Silvicultural Research Forest Division, Punjab)

This note summarises the record of the past work carried out in the Punjab during 1911-13.

General.—Experimental cultivation of the *Cryptostegia grandiflora* was done by the Punjab forest department in Changa Manga, Pabbi, Hoshiarpur, Kangra and Simla. The plant was found well adapted for cultivation under a wide range of conditions, on irrigated as well as dry areas, but the growth was vigorous where the supply of water was plentiful.

Changa Manga.—In Changa Manga sowings for raising seedling stock were done in June in raised nursery beds which were irrigated twice a week during first two months only. Germination was complete within a week. The seed bed development of seedlings was good, an average height of about 2 feet being attained in 3 months, with a maximum of over 4 feet in individual cases. The seedlings were ready for transplanting in the same season.

Pabbi.—In Pabbi, seed was sown in beds laid out on rich soil in the valley bottom. The ground was worked to a depth of about 2 feet. Sowings were also carried out in pots. Hand watering was done in beds as well as pots. In 3 weeks after sowings, the seedlings were about 6 inches high and with 4 to 8 well developed leaves. The seedling growth was quicker in the pots than in the beds. Owing to the straggly growth of shoots some support was necessary when the plants were about 8 inches high; this was provided by means of *kana* sticks. In Hoshiarpur and Kangra unwatered sowings were tried. These were reported as successful, but record of subsequent development of seedling is not available.

Transplanting.—Planting was done in the form of 2 to 3 row hedges, the width of the hedge being 3 to 4 ft. The distance between plant rows in the hedge

was 12 to 18 inches, and 1 to 2 ft. between the plants. The planting pattern aimed at was a series of parallel hedges 3 to 4 ft. wide and about the same in height for convenience of tapping by hand. The successive hedge rows were separated by 2-ft. paths for labour engaged on tapping to walk round each hedge row.

Transplanting was done in August. The growth in height was rapid, plants being 4 ft. to 8 ft. high within 2 months after planting. Planting was successful on poor as well as rich soil. The stocking per acre was about 4,500 plants, 3,000 seedlings being obtained from 1 oz. of seed.

Injuries.—An unidentified insect, referred to as *Tela,* did much damage to tender growing shoots which were bitten off. The damage was selective, being confined to weaklings only. The plants recovered from the effects of injury but the growth was much retarded. The attack, however, was not severe due to the appearance of natural enemies of *Tela* in the planted area.

Porcupines were responsible for the destruction of tender growths. Observation showed that porcupines did not feed on the leaves or tissues of shoots but were fond of the juice which they greedily swallowed. The injury was not fatal to the plants but resulted in appreciable setback in growth.

Cockchafer grubs were the source of serious injury to plants, cutting the plant roots underground. The presence of insects was detected only after the affected plants became dead or dry, which could then be easily pulled out of the ground.

Tapping.—The technique of tapping latex by hand was worked out experimentally. The method followed was to cut off young growth successively, holding the cut portion to bleed into a cup containing a dilute solution of sulphuric acid. The latex soon fractionated in this solution into two parts, the coagulum which rose like cream on the surface and the milky fluid, two parts being completely separated in about 48 hours. The coagulum was dried in the sun, which was not considered satisfactory owing to the resulting discoloration of the dry product. Approximately the coagulum was 60 per cent. of the latex flow in the cup.

The yield from 4,500 plants (one acre) was 30 oz. and cost of collection Rs. 25 so that tapping by hand was not remunerative.

It was, however, found that the latex was copious from the bark of growing shoots, but increased with the age of the plant. It was estimated that the cost of collection from older plants could safely be taken about one-third the above figures, but even so hand-tapping was not considered profitable. With hand-tapping it was necessary to cut down the hedges close to the ground, and obtain fresh growth from fresh coppice.

Chemical Extraction.—Due to unprofitable hand-tapping and poor yield, experiments were conducted, at the request of the Punjab forest department, at the imperial institute, London, to determine the feasibility of chemical extraction of rubber. Samples of bark chips of varying thickness from stems of 2 to 3 inches in diameter were subjected to tests. The transverse section of bark revealed a number of rubber threads, but these were fewer than in the case of *Landolphia* bark. Rubber was completely extracted by repeated treatment with hot toluene and the solvent

removed by steam distillation. The analysis showed that the yield of crude dry rubber was 2.07 per cent. containing caoutchouc 1.37 and resin with colouring matter, etc., 0.70 per cent. That is, the caoutchouc and resin contents were 66.2 and 33.8 per cent. of crude rubber respectively. After purification for the elimination of resin and colouring matter, the residual yield of rubber (1.37 per cent.) was virtually equivalent to 1.5 per cent. of rubber containing 10 per cent. resin or 1.7 per cent. rubber containing 20 per cent. resin. The yield of rubber from 2 year-old *Cryptostegia* plants from the Bahamas was 0.57 of true caoutchouc.

The caoutchouc contents of *Cryptostegia* were very low compared with that of *Landolphia* barks which yielded up to about 8 per cent. true caoutchouc. Only the rhizome bark of bushy forms of *Landolphia* was used for extraction, the stem bark being poorer in yield.

The woody residue of stems was also investigated for the manufacture of paper pulp. The process of separating fibre from the bark was not found remunerative under the conditions of the experiment. The fibre was, however, suitable for the purpose.

Mechanical Extraction.—No satisfactory mechanical process for the extraction of rubber from the *Cryptostegia* bark with low caoutchouc contents was elaborated at the imperial institute. It was believed that even if the whole of the rubber from the mechanically-pressed juice were extracted with solvents, the process would not be a success, as the treatment for the purification of the crude product was likely to be costly.

However, a French firm interested also in the cultivation of *Cryptostegia* was believed to be working successfully with a mechanical extraction plant in Madagascar. The species cultivated by this firm was *Cryptostegia madagascariensis* and not *grandiflora*. For cultivation, *Cryptostegia* was preferred to *Landolphias* because it was the more easily-propagated species. Adequate information on the yield and financial aspect of mechanical extraction is, however, not available. It is recorded that only in exceptional cases did the yield of a single plant of *C. madagascariensis* exceed 120 grams of rubber from 4 litres of latex, that is, 30 grams per litre.

It is probable that the mechanical plant introduced in Madagascar was manufactured by Messrs. Valour Rubber Extracting Machine Limited, Paris. The advertised price of the plant in batteries of 6 units was £900 plus a royalty of $7\frac{1}{2}$ per cent of the final product manufactured. The machine is a self-contained plant including a boiler suitable for wood fuel and of $3\frac{1}{2}$ to 4 horse-power, the whole equipment being in sectionalized units for easy transport.

In India a similar plant was imported by the Karnal Company. It was essentially a roller mill adjusted to press the bark for the extraction of juice. Actually the machinery, as supplied by the manufacturing firm, was not found satisfactory, so additional equipment had to be added subsequently. On the whole, the working of the machinery was not successful, the chief difficulty being the impurities of bark sap getting into the crude product.

HOW BEST TO UTILIZE THE MAJOR LAC HOSTS OF CENTRAL INDIA

BY BHAGAT SINGH CHHABRA, M.R.H.

(Range Forest Officer, Indore State, Central India)

There are four major lac hosts in Central India which are mostly utilized for lac cultivation: (A) Two *kusumi* hosts; and (B) Two *rangeeni* hosts.

(A) *Kusumi* hosts are:

(1) *Kusum Schleichera trijuga;* and

(2) *Khair* (*Acacia catechu*).

(1) *Kusum*: *Kusum* is the lac host which tops all other hosts in respect of better quality and quantity of lac yielded. The only drawback with this host is that unlike other hosts it gives only one crop in $1\frac{1}{2}$ years.

It is an *aghani* and *jethwi* host. For the *jethwi* crop *kusum* should be pruned 18 months before infection in June-July and infected in January-February, cutting the crop in the following June-July. For the *aghani* crop trees are pruned in January-February and infected after 18 months in June-July, cutting the crop in January-February.

The general principles of pruning this host are that it does not stand heavy pruning. It takes considerable time to recover and when pruned by the *raiyat* method it takes 2 or 3 years to respond. The best way of pruning this tree is to prune it very lightly except when pruning old trees or pruning the trees for the first time in which case they will be pruned rather heavily—cutting ragged, dead and dying branches and branches which are not accessible. In this case also the shape and general health of the tree should be maintained. In general the most satisfactory results are obtained by cutting at a thickness of three-fourth to one inch and in the secondary pruning the crop-cutting itself acts as pruning for the next infection. The following diagrammatical figure will illustrate the best use of pure *kusum,* following 18 months' rest after pruning. The area is to be divided into four groups. This tree can best be alternated with *khair*. *Khair* yields the same quantity and quality of lac when infected with *kusum* brood or progeny of *kusum* brood. *Khair-kusum* combination is given with the description of *khair*.

Coupes of *kusum*:	A	B	C	D
Prune ..	February, 1938	July, 1938	February, 1939	July, 1939
Infect ..	July, 1939 ↓	→February, 1940 ↓	→July, 1940 ↓	→February, 1941 ↓
Crop ..	February, 1940	July, 1940	February, 1941	July, 1941
Ready for reinfection ..	July, 1941	February, 1942	July, 1942	February, 1943

(Arrows indicate transference of brood)

and so on.

Note—In this paper *kusumi* refers to lac grown on *kusum*, (*Schleichera trijuga*) or transferred from *kusum* to other trees; *rangeeni* refers to lac grown on trees other than *kusum* and not derived from *kusum*.

Aghani and *jethwi* are *kusumi* crops harvested in December-January and June-July respectively, *Katki* and *baisakhi* are *rangeeni* crops harvested in October-November and April-May respectively.—Ed.

(2) *Khair*: It is a *kusumi* as well as *rangeeni* host. For *kusumi khair* should be used only for the *aghani* crop and not for *jethwi* crop as *khair* does not stand the pruning of *jethwi* crop which is done in June-July. When used for the *rangeeni* crop it should be used for the *katki* crop and not for the *baisakhi* crop. The reason for not using *khair* for *jethwi* and *baisakhi* is that it does not get sufficient vitality to support the crop in the late winter and early hot weather months. The resting season begins between January and April and during this period there appears to be very little rise of sap in this host. July pruning is also harmful to the tree and if done, one should not expect to get suitable shoots for January or October infection. *Khair*, therefore, should be infected in June-July. When using *khair* for *aghani* it should be pruned in January-February ond infected in June-July and when using for *katki* crop it should be pruned in October-November for June-July infection.

Khair, when desired to alternate with *kusum*, the area should be divided with one coupe of *khair* and two coupes of *kusum*. The crown of *khair* is smaller than the crown of *kusum*; therefore, *khair* trees in that coupe should be taken accordingly (1 *kusum* = 4 to 6 of *khair*). The *khair-kusum* combination is given below

	A. Kusum Coupe		*Khair Coupe*		*B. Kusum Coupe*
Infection	.. February, 1939	Prune	.. March, 1939	Prune	.. July, 1938
	.. (Pruned in July 1937)	Infect	.. July, 1939	Infect	.. February 1940
Crop	.. July 1939	Crop	.. February, 1940	Crop	.. July 1940
	18 months rest	Infect	.. July, 1940		18 months rest.
Infect	.. February, 1941	Crop	.. February, 1941		
Crop	.. July 1941	Infect	.. July, 1941		
		Crop	.. February 1942	Infect	.. February 1942

and so on.

Khair is susceptible to heavy pruning and, as such, it should be pruned lightly by cutting branches three-fourth to one inch.

B. *Rangeeni hosts*:

(1) *Palas* (*Butea frondosa*), and

(2) *Ber* (*Zizyphus jujuba*).

(1) *Palas*.—*Palas* is an important *rangeeni* host which carries both *baisakhi* and *katki* crops.

To get good and maximum lac out of this host it should be properly pruned and infected. *Palas* stands heavy pruning and even pollarding. To prune it for the first time it should be heavily pruned and all ragged, dead and dying branches must be cut off from their origin near the main branch. Branches $1\frac{1}{2}$ to 2 inches in diameter or even thicker can be cut if the branch is becoming inaccessible.

For the secondary pruning cuts should be given to the new shoots which have arisen from the preliminary pruning; *i.e.*, cut should be three-fourth to one inch thick. Branches less than this should be cut flush to the main branch. At places where wiry shoots have come up or the end of the branch has become knotty, it should be cut below the knot or below the origin of the wiry shoots to get better shoots next time. The idea of increasing the canopy of the tree should be kept in mind.

Palas in temperate climates should be divided into three coupes:

	A		B		C	
Prune	.. February, 1939		April-May, 1939		February, 1940	
Infect	.. June, 1939	K	October, 1939	B	June, 1940	K
Crop	.. October, 1939		June, 1940		October 1940	
Reinfect	.. October, 1940	B	July 1941	K	October 1941	B
Crop	.. July, 1941		October, 1941		July, 1942	

(K= *Katki* and B= *Baisakhi*)

and so on.

Note.—For October infection intermediate pruning in April and for June-July infection intermediate pruning in February will be required; as one-year-old shoots will not be suitable for reinfection.

In hot and arid places *palas* should be worked as follows:

By general experience it has been discovered that a successful crop on *palas* occurs only about once in every three years. It is, therefore, important to have as many trees as possible infected to take advantage of this full crop when it occurs.

Palas may be roughly divided into the following groups in hot places:

(1) Brood producers.

(2) Brood producers in a good year.

(3) Non-brood producers.

The trees may be worked as follows:

May, 1940.—Prune.

October-November, 1940.—Infect as many trees as possible with the brood available in the order given above.

May, 1941.—Cut all non-brood producers completely and the rest two-thirds. This two-third reaped lac should include all dead and unhealthy lac. Leave one-third healthy lac on trees for natural infection in July.

July, 1941.—Natural infection allowed to occur on all trees.

October-November, 1941.—Brood producers of class I are cut two-third and the remaining one-third healthy lac is left for natural infection. Of course, those trees of this type which are fully infected and have no space for larvæ to settle are completely cut. The two-third lac obtained by partial cutting should be utilized to infect artificially fresh trees in the above said order again, *i.e.,*

(1) Brood producers of class I.

(2) Brood producers of class II.

(3) Non-brood producers.

Natural infection of brood producers of class I for *baisakhi* crop is opposed to the Forest Research Institute advice. It is, however, unavoidable in hot and arid places where the number of brood-producers among the trees is small.

In a bad year lac will survive on brood producers of class I only. In a moderate year brood will survive on trees in category 2. In a moderately good year the number of brood-producers of classes I and II will be pretty high. Consequently, if the brood-producers of class I are completely cut in April-May, there will be no harm done because brood-producers of class II will give enough brood for July natural infection and there will be no scarcity of brood in the following October and at the same time brood-producers of class I will also be available for October-November infection.

Palas is alternated with *ber* also. *Palas* for *baisakhi* and *ber* for *katki* crops.

(2) *Ber*: *Ber* is used both for the *baisakhi* and the *katki* crops; but it is better to use this host for the *katki* crop only where other hosts exist to alternate with this. The pruning of this tree is done according to the general rules of pruning. *Ber* in temperate climates is divided into three coupes and worked as under:

		A. (*Katki* coupe).	B. (*Baisakhi* coupe).	C. (*Baisakhi* coupe).
Prune	..	March, 1937	April May, 1937	
Infect	..	July, 1937	October November, 1937	
Crop	..	October-November, 1937	June-July, 1938	
Reinfect	..	June-July, 1938		
Crop	..	October-November, 1938 →		Infect—October-November, 1938
Infect	..	July, 1938 ←		Crop — July, 1938

Note.—The *baisakhi* coupes after cropping in July will require re-pruning the following April-May.

In places where intense heat occurs in April-May, lac does not survive on *ber* to give brood in July. Therefore, the whole crop is cut in April-May. In such places the preservation of brood for July infection is a great problem and every year brood has to be purchased from outside.

In order to tackle this problem, the Indian Lac Research Institute at Namkam (Ranchi, Bihar) is carrying out the research work.

The trees are partially pruned at different periods, *e.g.*,

(1) Partial pruning in October before infection.

(2) Partial pruning in November at the time of infection.

(3) Partial pruning in December after infection.

The underlying idea of this operation is to make the tree put forth new leaves in hot weather to cover the lac from the hot winds of summer. The results are yet under experimental stage and nothing definite can be said at present.

General.—The trees should be pruned with sharp pruning instruments according to the pruning rules which are:

(1) General health and vigour of the tree should be maintained.

(2) Cutting should be done in such a manner as to keep a good shape to the tree and allow plenty of room for the new shoots.

(3) All dead and diseased branches should be cut.

(4) The thinner the branch, the nearer the main stem should it be cut.

(5) The cut should be a clean cut.

And, above all, the trees should, as far as possible, be infected with brood free from parasites and predators.

The annexed statement will give a general outlook of working the major lac hosts.

STATEMENT SHOWING DIFFERENT LAC CROPS, THEIR DATES OF PRUNING, INFECTION, MALE EMERGENCE, CROPPING, PERIOD OF MATURING AND THE LAC HOSTS TO BE INFECTED

Crop	Period of Pruning	Dates of Infection	Male emergence	Cropping period	Maturing and giving rise to the swarming larvæ	Period required to mature	Host Trees	Remarks
(A) *Rangeeni* (1) *Katki*	February, 6 months earlier.	June-July	August-September	October-November	October-November	3½ to 4 months	*Palas* *Khair* *Ber*	
(2) *Baisakhi*	April-May, 6 months earlier	October-November	February-March	April-May. Leaving a certain amount of lac on the tree to mature and act as brood in July.	June-July	8 months	*Palas*, *Ber* * *Khair**	
(B) *Kusumi* (3) *Aghani*	January-February, 18 months earlier	June-July	September	December-January. Lac not required for brood.	January-February	6 months	*Kusum* *Khair*	
(4) *Jethwi*	June-July, 18 months earlier	January-February	March-April	June-July	June-July	6 months	*Kusum* *Khair* *	

*These species should not be tried to raise the crop shown against their names.

THE DAMODAR, BENGAL'S RIVER OF SORROW

By S. K. Basu, M.sc.,

Deputy Conservator of Forests,

Divisional Forest Officer, Kalimpong, Bengal.

I have read with great interest Prof. Saha's valuable article in the *Amrita Bazar Patrika* dâk edition of the 16th August, 1943. It appears, however, that while Prof. Saha has considered the symptoms of the disease and their treatment, the root of the matter has not been exposed.

As Prof. Saha says, "During the major part of the year, the bed lies covered with dry, coarse sand, while during the monsoon it swells with all the fury of a hill stream. The upper catchment area of the Damodar measures 4,200 sq. miles and that of the Barakar is 2,650 sq. miles. If there is heavy precipitation in these areas, a flood in the lower basin is sure to occur. Nay, the flood can almost be predicted within hours. . . ."

Quite so. This is how floods occur in the Damodar. But is there no remedy to this state of things? Is there no sure way of *preventing* such a state of things in which every heavy precipitation is sure to be followed by a flood?

There is such a way as has been fully recognised by every civilised country. This consists in afforestation of the upper catchment areas of the river.

In order to get at the root of the matter, we must consider erosion and how the presence of a forest controls erosion.

In an area covered by forests, the soil is deep and rich, owing to accumulation of dead leaves and branches. The top layer of a forest soil even in sloping country may be anything up to 8 or 10 feet deep or more. This layer, again, consisting as it does, of decaying and semi-decomposed leaves, roots, etc., is of a spongy character.

When rain water falls on a forest, therefore, the force of the water is broken first by the crowns of the trees and then by the litter on the ground. This prevents the raindrops from beating the soil particles into suspension, thereby clogging the pores and reducing percolation. The water, therefore, instead of being washed away along the surface of the ground, largely enters the soil through infiltration. The spongy soil, again, holds back the greater part of the water, only allowing it to pass through in small quantities at a time. This is the reason why the catchment areas of the water supply in hill stations are always kept well wooded. Had this not been done, the rain water would have been quickly carried down soon after it fell and there would be no water available in the dry season. The presence of the forest ensures a perennial supply.

Another benefit arising from the presence of a forest is that any water that does run off from forest areas is clear and carries little sediment with it.

Now, let us consider what happens when such a hilly country as Chota Nagpur is gradually denuded of forests.

In the first place the soil, perhaps loosened by cultivation, is gradually carried off by rain and sheet erosion begins. The next layer of soil exposed is less absorbent,

the amount of runoff water increases and rate of erosion is accelerated. Little by little, the top cover disappears and, there being no soil to hold the rainfall, it is all quickly and immediately carried down into streams and rivers, swelling the rivers into floods, perhaps hundreds of miles away from the site of the rainfall. Disforestation and erosion in the hills thus result in floods which gradually, as the erosion continues, become more and more frequent and destructive and, in such a state of things as has been described by Prof. Saha, in which every shower of rain, instead of coming down as a blessing from heaven, is actually dreaded as a source of danger.

Another evil effect of erosion resulting from disforestation is that the rain water in coming down the bare hills carries more and more sand (increasing the erosive action of the water) and mud which are deposited in the river-bed and on the river-banks, raising their levels. Thus, navigation is impeded, the silt fails to reach and enrich the surrounding country which again becomes full of beels and swamps as the natural drainage of the country into the rivers is impeded. The sources of branch rivers get clogged. The muddy water in the river is also inimical to fish life.

Prof. Saha has recommended the building of reservoir dams as a "permanent remedy." Experience has, however, shown that "the engineer alone cannot permanently control a great muddy river continually being supplied with millions of tons of eroded soil. The artificial banks must be raised ultimately to breaking point; as the river rises, the dams built to trap the water also trap silt and clay which choke the reservoirs behind the dams and the last state of the river is worse than the first. . . ."

I am not saying that dams and embankments are not necessary. They must be built to save life and property immediately but it must be recognised that these remedies are not permanent cures as Prof. Saha claims them to be but temporary palliative measures that must be taken to keep the patient alive so long as the permanent remedy takes time to act. In fact, in the natural course of things, a river should not require to be embanked excessively to control floods. In course of time, it should erode its own bed to a depth ordinarily sufficient to keep the water between its banks. It is only "when eroded soil from upstream regions fills the bed and excessive runoff from eroded land makes the once abnormal flows normal occurrences (that) an artificial and dangerous passage has to be built above the level of the plain."

The only sure and permanent remedy of the Damodar floods is afforestation of the catchment areas. As is usual with neglected and chronic diseases, this permanent remedy admittedly acts very slowly but a start has to be made some time and the sooner the better. There are serious difficulties in the way. These catchment areas lie hundreds of miles away in a different province. Vested interests, private estates and agricultural customs are involved. But let the urgency of the matter be fully recognised for once and let it be realised that the fate of the rivers which are the sources of Bengal's life blood depends upon it and no difficulties will be found to be really unremovable.

EXTRACTS

TERMITES AND SOIL FERTILITY

[*The Farm and Forest* issue dated November, 1942, gives some interesting translated extracts from a paper of L. G. E. Kalshoven, made available by the courtesy of the Imperial Forestry Bureau to that journal, which we reproduce below with acknowledgments to the journal and the bureau.—*Ed.*]

Natural Supply of Animal Matter.—In a very interesting, richly illustrated article by Troll (1936) on "termite savannas," which was unknown to Vagelar, it is made clear that the mound-building activities of a few termite species, combined with grass fires, has made possible the existence of groups of trees in the grasslands of Africa. Troll assumes that the termite mounds are rich in organic matter, but also emphasizes the special physical constitution of the places that they inhabit. A relation between termite life and the 'park' formation in the African landscape had already been established by Fuller, a specialist on termites, in a still widely known paper in 1915 (? misprint for 1935, *see References.*)

Experience and opinion on this question in the Netherlands East Indies may be stated thus: In building their nests some termites use soil particles, which they mix with a kind of saliva and use for their 'masonry.' These parts of the nests are strikingly clayey and become very hard when dry (they are popular with the native children for making clay models). Hardon, who investigated some samples of this clay from nests of one of the commonest ground termites (*Macrotermes gilvus*), could not establish any chemical (or even physical) difference between these and soil from the immediate vicinity of the nest.

In his thesis on the systematic soil survey of South Sumatra, Idenburg (1937) states that termite mounds and columnar structures up to 3m. high were observed, especially on land that is periodically under water. "When the site is flooded, these hills function as chimneys through which water evaporates. Here, therefore, the movement of water is upwards, and thus salts in solution are transported. As the water evaporates all the soil colloids become saturated with bases and sesquioxides, whereby first the sesquioxides and then the alkalis are deposited at the base of the termite hills in the form of concretions."

A few observations on the relation between plant growth and termite mounds have been made in the country between Tjikampek and Djatibarang, where the mounds occur in great numbers and give a peculiar aspect to the landscape. They are largely relics from the time when the area was still covered with thick jungle (*rimboe*). They are most striking in the rice fields (*sawah*), where they sometimes number 3-4 per *patak* and have mostly a flattish, broad shape, with a diameter of up to 5m. and a height of about 1m. They are also numerous in the fire savannas and grasslands, particularly those of Siil (*Andropogon amboinensis*) to the south of the railway. Here they are more or less conical and often up to 1½m. high. A description of this area has been given by Van Steenis (1936). The rather uniform distribution of the mounds over the savanna area, where there are 15-20 per *ha.*, may be

seen from photos from the aerial survey carried out for the Forest Service. It is noteworthy that the Siil grass on the termite mounds grows about twice as tall as on the remainder of the site, where more *Cyperaceæ* also occur, and in many cases such trees as are present grow exclusively on or adjacent to the mounds. This characteristic growth of trees and shrubs on the mounds, which appear to be preserved for a long time even on cleared areas, must have originated largely after the formation of the mounds, and the previously held view that the mounds were constructed in pre-existing groves of trees is incorrect.

In the neighbourhood of Tjikapek the natives regard the soil of the mounds in the rice fields as infertile and call it 'tanah aseum' (sour ground), though elsewhere the contrary opinion is heard. As reasoned for the fact that the mounds are not often dug out when rice fields are first established or later, the following are given: that it would take too much time and trouble, since the soil is hard and often carries stumps or individual trees of some size; that the site would be raised to too high a level and would thus be harder to flood (so that the soil dug would have to be transported elsewhere, which would be expensive); and that the termite hills are used for dumping all kinds of garbage and superfluous soil, besides as resting places, for example for the construction of a 'goeboeg' or hut. It is acknowledged that the mounds occupy an excessive area, but there is no scarcity of land.

During the establishment of teak plantations in this region on the (yellow-)grey quartz loam soils of Indramajoe it was observed that the young trees, including the *Lamtoro, Leucæna* sp. (probably *L. glauca,* the species most commonly used for ground cover and soil improvement) did fairly well on land in the immediate vicinity of the mounds, but that elsewhere symptoms of ill-health appeared. In the worst parts of the plantation the termite mounds are recognizable from a considerable distance by their richer growth and greener colour. According to Muller the symptoms of ill-health show some resemblance to those due to boron deficiency in tobacco (report of 20th July, 1936). The better growth on and near the mounds was in his opinion attributable rather to the better supply—due to the greater evaporation from the termite mounds—of substances needed in small quantities, than to an improvement in the structure of the soil, considering that the effect was observable at some distance from the mounds. It has since been established, however, that the real nest of the termite species in question (*Macrotermes gilvus*), *i.e.,* the portion where the large cavities with fungus beds occur, may extend for some distance from the mound, in a circle which may be of 5-6m. radius.

Further research, particularly on the composition of the soil used by the termites in their nests and galleries, and on their mode of life, would be needed to explain precisely the phenomenon just mentioned, and to determine whether the differences from soil uninhabited by termites are due to the habit of the insects of bringing dead plant material into the soil for further conversion, or to the changes that they cause in the physical character of the soil. Against the opinion that the mounds should contain a greater supply of plant nutrients, it may be stated that few of our subterranean termites lay out fungus gardens, and that the storing of food reserves by the termite species of the Netherlands East Indies is of even rarer occurrence. It may

also be pointed out that the termites are extremely economical with the plant materials that they collect. In some species the materials are passed several times through the body by re-consumption of excrement, or the excreta are utilized in constructional work and so fixed for a long time.

The breaking down of dead organic matter.—The action of termites in breaking down dead plant materials is chiefly useful in that it makes available to other organisms the material not used by the termites for food. This is particularly so in the case of wood, which is not so readily broken down by other agencies, but which they attack even when it is bulky or in the form of dead standing trees. They tunnel in the wood, provide a regulated moisture supply—this being a necessary condition of life for most species of termite—and transport numbers of fungi. They also consume bark, hard fruit shells, bamboo stems and the like. The material that chiefly serve them for food is cellulose, which is digested with difficulty or not at all by other insects and the higher animals.

Their activity is often somewhat exaggerated, especially as regards the rapidity of the destruction that they bring about. Furthermore the heartwood of any tree species is more or less resistant to their attack. In the destruction of such stems the preliminary work is presumably done by secondary borers of various kinds and saprophytic fungi, and termite attach follows only later.

Besides the woody portions of plants, fallen leaves and dead grass stalks are also much used by the termites. Their liking for all kinds of dead plant material is also evident from the frequency of their occurrence in peat lands that have been brought into cultivation in Sumatra (Van Heurn, 1922), from their often observed excavation of manure heaps and pasture soils and their regular appearance in land treated with stable manure. Certain species (*Capritermes* spp.) appear to live wholly upon humus.

The working of the soil by animals.—The very general occurrence of underground excavations and tunnels made by termites, and their widespread existence in cultivated land may be readily observed during deep soil working and other operations in which the soil is disturbed. It may be said of Netherlands East Indies, as of other tropical regions, that except in flooded and very sandy places the ground is almost everywhere undermined by termites. The depth to which some species penetrate depends upon the ground water level and may be at least as much as 4m. Elsewhere galleries have been observed at much greater depths. Termite life is more abundant in the plains than on mountain slopes, but ground termites have been found up to 1600m. above sea level.

The most important termites causing these displacements of soil are various soil-inhabiting species that seek their food above ground and in doing so make tunnels constructed of soil particles in order to maintain themselves in a moist atmosphere. A mode of working frequently to be observed is the sheathing of parts of living stems with broad plates of earth under which the termites eat away the dead portions of the bark. On some sites this happens very commonly. There has apparently been little research on the extent of such soil displacement, though it would certainly repay investigation.

Some termites (in Java, so far as is known, only *Macrotermes gilvus*) also bring considerable quantities of soil upwards when constructing the mounds in or under which their nests are situated. *Macrotermes gilvus*, however, makes such mounds only locally in the areas where it occurs. Factors that evidently inhibit mound-making are: (*a*) low water capacity and poor permeability of the soil, which quickly becomes soggy; (*b*) possibly also the presence of hard layers or stony constituents in the ground; and (c) the absence of cultivation and of the soil disturbance that it involves. Apart from these the colony must have reached a certain size before mound-building is begun. The first preliminary to this activity is the extension of excavation of the soil for fungus gardens and for the central portion of the nest round the royal cell.

As previously observed, the strongly developed and sometimes peculiar vegetation of termite mounds is possibly attributable mainly to topographical and physical differences in these heaps of soil with their many excavations.

That the conditions for plant growth may sometimes be unfavourable appears from an examination of old termites mounds on pasture land at Djatibarang, where at the end of the dry season the short growth of grass on and around the mounds was observed to be dead, roots and all, apparently as a result of excessive desiccation.

REFERENCES

Fuller, C. .. .. Termite economy, S. Afr. J. Sci. 1935 (quoted in text as 1915).

Huern, F. C. Van .. De gronden van het cultuurgebied von Sumatra's Oostkust en hun vruchtbaarheid voor cultuurgewassen, Asterdem, 1922 (p. 21.)

Idenburg, A, G. A. .. Systematische grondkarteering von Zuid Sumatra. Wageningen, 1937, p. 118.)

Steenis, C. G. G. J. Vau .. Landschap en flora in Indramajoe. *Tropische, Nature*, 12, 1936 (III).

Troll, C. .. .. Termitez Savannen. Studien zur Vegetations-und Lands-chaftskund der Tropen. II. *Landerkundliche Forschung Festschrift Norbert Krebs.* 1936.

—*Farm and Forest*, Vol. III, No. 4, dated November, 1942.

NUTRITIVE VALUES OF *PROSOPIS JULIFLORA* PODS AND SOME GRASSES

1. *Feeding value of ripe and dried pods of Prosopis juliflora.*—The feeding value of dried Prosopis pods was determined by the Agricultural Chemist to the Government, Punjab, Lyallpur, by actual tests on Montgomery heifers. The results are given in the table below along with the comparative data for maize grain, barley grain, and wheat bran.

Name of feed.	Chemical Composition							Per 100 lbs of the Feed		
	Moisture %	Dry moisture %	Ash %	Fat %	Fibre %	Protein %	Nitrogen free extract %	Starch equivalent lbs.	Digestible protein lbs.	Nutrition period days
1. Ripe dried pods of *Prosopis juliflora* ..	8·45	91·55	6·41	1·25	28·01	12·25	43·63	56·03	8·00	6·6
2. Maize grain ..	8·99	91·01	1·95	3·51	1·84	9·31	74·40	81·05	5·60	12·6
3. Wheat bran ..	8·80	91·20	5·86	2·63	10·02	13·56	59·13	43·85	10·45	3·5
4. Barley grain ..	8·40	91·60	3·83	1·59	6·29	8·88	71·01	64·41	6·89	8·9

The above figures indicate a high nutritive value of the pods, as shown by their contents, 8 lbs of digestible protein and 56 lbs of starch equivalent per 100 lbs of pods weight. As a cheap source of digestible protein, the pods can be utilized, where available, to make up the protein deficiency of such roughages as wheat, *bhusa* and rice straw, which when fed alone usually do not constitute a maintenance ration.

2. *Investigation of the nutritive value of natural grasses from the Pabbi and Salt Range areas.*—The results of this investigation giving comparative yield and composition of grasses are now available.

In this study, intensive sampling was done of the representative Pabbi grasses only in the Reserved Forest near Banni Rest House, in areas selected in Block A, on the ridge, near the valley bottom and also in the shamlat. In the Salt Range mixtures of grasses were sampled only from Rakhs Garat, Jandi, Ganda, and the Reserved Forest near Kallar Kahar.

The Pabbi grasses comprised the following species:

1. *Cynodon dactylon*, Pers. *Khabbal.*
2. *Canchrus ciliaris*, Linn. *Dhaman.*
3. *Eleusine flagellifera*, Nees. *Chhimbar.*
4. *Cymbopogon jwarancusa*, Schult. *Khavi.*
5. *Aristida depressa*, Retz. *Lumbi.*
6. *Digitaria bicornis*, (Lam.) R. & S. *Pharion.*
7. *Chrysopogon montanus*, Trin. and *Chrysopogon gryllus*, Retz, mixture. Tila.
8. *Panicum psilopodium*, Trin. *Chhura.*

Comparative data were collected under two different methods of grass cutting, namely—

(a) cutting at successive developmental stages under conditions of uninterrupted growth, and

(*b*) repeated clipping of fresh grass periodically to imitate natural grazing.

The developmental stages investigated were:

(*i*) Succulent stage, when the height growth is about 6″—8″.

(*ii*) Flowery stage, when the flowering has commenced.

(*iii*) "Milk" stage, when the seed is in succulent condition.

(*iv*) Ripe stage, when the seed has ripened.

(*v*) Dry stage, when the grass has dried up.

The results of chemical analysis and yield are summarised as below:

A.—Grass-cutting at Developmental Stages

(*i*) *Protein, phosphoric acid and potash.*—There is a progressive decrease of these with the ripening of grasses. However, the decrease in protein contents of the Pabbi and Salt Range grasses is not as great as with the Nurpur grasses. In fact, the protein contents even at the later stages of growth of grasses (except *Artistida depressa* and *Chrysopogon montanus* and *Chrysopogon gryllus*) compared favourably with those of hays which when fed to heifers at Lyallpur formed maintenance rations. In contrast with protein, the fall in the phosphatic contents is very great, being even greater than with the Nurpur grasses.

(*ii*) *Lime.*—The grasses are very rich in lime contents, which remain practically constant at all stages of growth.

B.—Comparison of results as between clippings and cuttings at developmental stages of grasses

(*i*) *Protein, phosphoric acid and potash.*—The herbage obtained by repeated clippings is richer than grasses cut at successive or advanced developmental stages

(*ii*) *Dry matter and lime.*—The yield from repeated clippings is lower than from grasses cut at successive stages of growth. Compared with the Lyallpur soil, the Pabbi and Salt Range soils are lighter in texture, poorer in available phosphorus and richer in organic and calcium contents. This is reflected in high lime and low phosphorus acid contents of these grasses.

GIANT STAR GRASS

Cynodon plectostachyum is an African cousin of our familiar dub, *Cynodon dactylon*, (Bermuda grass), which it excels by far in growth performance. It makes a luscious dense stand with amazing net-work of robust runners. Individual plants are known to have covered in less than six months more than 8,000 sq. ft. of soil with runners measuring in length more than 50 ft. The grass has thus great possibilities for erosion control in areas where it can be successfully established.

In actual trial with this grass at Almora, 4 ft. height was recorded in four months. Planted in May 1940, harvested once in January and again in June 1941 and finally uprooted in October 1941, the fresh weight of a single plant was nearly a maund, and of hay 25 lbs. This is by no means the record yield from the harvest of a single plant.

The grass is definitely *cyanogenetic,* that is, contains hydrocyanic acid, which is one of the deadliest of poisons. However, in the feeding trials at Almora, it has been found quite safe. The hay holds no risk of poisoning, but the grass is not recommended as a green fodder until 3 months old. The poison content is at its maximum when the rains set in.

FOREST BOTANY

I.—Ecology

Nurpur Grass Plots.—Observations were continued on the ecological succession and yield of grasses. *Apluda aristata, Dichanthium annulatum, Heteropogon contortus* and *Chrysopogon montanus* continued to occupy the *Cenchrus* plot. The dominance of *Bothriochloa pertusa* was variable in different plots, while *Sorghum halepense* and *Cenchrus ciliaris* could not maintain themselves under conditions of free competition.

The average yield of mixture of grasses in these plots was 71 maunds per acre during the year against 82 maunds last year. The progressive falling off in the yield is ascribed to changes in the ecological balance of the area due to increased soil moisture resulting from contour trenching and heavy rainfall during the year.

—*Punjab Forestry Notes* No. 8, June, 1943. (Issued quarterly by the Chief Conservator of Forests, Punjab, Lahore).

THE IMPORTANCE OF RACE IN TEAK, *TECTONA GRANDIS L.*

BY J. S. BEARD,

Assistant Conservator of Forests, Trinidad and Tobago.

Summary: Teak has been raised in Trinidad from seed imported both from India and Burma. There are marked differences between the quality of the two strains, and vegetative differences which divide them into separate "races". In Java several distinct races of teak are recognised and trials have shown those from Burma and Siam to be the best. Those who wish to introduce teak in tropical America should be careful as to the source of their seed.

Teak is one of the foremost timber trees of the east and is native to monsoon-type forests (*i.e.*, where there is a seasonal alternance of wet and dry seasons) in India, Burma, Siam and Indo-China. Centuries ago it was introduced into Java where it became naturalised, and was widely planted, so that in 1930 Java possessed 720,829

hectares of pure teak forests (1,800,000 acres). In view of its peculiarly fine qualities, teak has been carried to all the corners of the tropics. It arrived in the West Indies during the nineteenth century and old trees may be seen in various botanical gardens. It does not seem to have been tried as an economic timber crop, however, until 1913, in which year Mr. C. S. Rogers, Forest Officer, Trinidad, imported a small parcel of teak seed from Tenasserim in Lower Burma. Two small plantations were established in Trinidad which at the time of writing are just 30 years old. These trees yielded seed, with which trials were extended. Such success resulted that the species was taken up as a major commercial proposition and is now being planted at the rate of some 400 acres annually. All the seed required for annual operations is obtained from trees which were raised from seed collected in the plantations of 1913: in other words, present plantings are in the second "creole" generation.

The teak thus being grown in Trinidad fall, according to sample plot measurements, in a quality class slightly above the average of Quality II of Nilambur, India, according to the Nilambur yield tables. They are subject to no pests or diseases and are of excellent bole form.

In 1935 the late Professor R. S. Troup suggested that an investigation should be made as to whether Trinidad's stock was satisfactory or could be improved by fresh importations of seed from selected strains. There was reason to believe that the seed brought from Tenasserim had been collected from low, branchy trees in the paddy fields, though there was no evidence that these trees were genetically distinct from true forest teak. A request was therefore sent to the silviculturist at the Forest Research Institute, Dehra Dun, India, for selected samples of seed, and a reply was received as follows:

> "I have asked the silviculturists of Burma and Madras each to send you 4 lbs. teak seed from their best moist teak localities. There are well-defined vegetative differences between the teak from these two localities though inherent timber and bole form differences have not yet been systematically sought for or discovered."

In June 1936, 4 lbs. of teak seed were received in Trinidad from Shencottah Division, Travancore State (Southern India) and were sown. No seed arrived from Burma. Unfortunately most of the seed sent did not germinate and for the planting season of 1937 (June) only about 150 plants were available. A plot containing 0.137 acre was however formed in the 1937 teak coupe at the Southern Watershed Reserve by the standard local method of stump-planting at 6×6 feet. The plot is located at an altitude of 200 feet and receives an annual rainfall of 65 inches. During the dry season from January to April $\frac{1}{2}$ to 3 inches of precipitation falls monthly. During the rest of the year it varies from 4 to 14 inches monthly. The soil is a silty clay derived from a sedimentary formation. The aspect is southeast; the slope is moderate; and drainage is good.

The plot is entirely surrounded by teak of the local stock, which will be referred to as "Burma teak" in distinction to the "Indian teak."

At six years old the plot of Indian teak was thinned and measurements were taken with the result shown in Table I.

TABLE I.—A COMPARISON OF THE GROWTH OF INDIAN AND BURMA TEAK

Criteria.	Indian Teak.	Burma Teak.[1]
Standing Crop after Thinning—		
Number of trees per acre	493	615
Average tree girth at 4 ft. 3 in. in inches	14·75	14
Total height—feet	32	42
Average height of dominants—feet	36	47
Form factor	·156	·204
Bark per cent.	53	30
Basal area per acre—sq. ft.	46·0	48·9
Volume per acre under bark—cu. ft.	230·0	312·5
Intermediate Yield—		
Number of trees per acre	456	362
Average tree girth at 4 ft. 3 in. in inches	10·75	10·50
Total height—feet	31	38
Basal area per acre—sq. feet	23·1	14·4
Volume per acre under bark—cu. ft.	98·6	72·6
Total Crop—		
Basal area per acre—sq. feet	69·0	74·3
Volume per acre under bark—cu. ft.	328·6	385·1
Mean Annual Increment—		
Basal area per acre—sq. feet	11·5	12·4
Volume per acre under bark—cu. ft.	54·8	64·2

The comparative figures shown were obtained by averaging the figures of three sample plots in Burma teak on similar soil and situation within a radius of half a mile from the plot of Indian teak. These three sample plots agree fairly closely in quality with each other and also, according to the measurement of a few selected trees felled, with the teak immediately surrounding the Indian plot. It is unfortunate that the latter is so very small: more accurate measurements could have been taken if it were of larger area.

A heavier thinning is shown as having been made in the Indian plot. This is merely in accordance with recent practice in Trinidad, the comparative figures dating from 1935-37. It does not affect the results under consideration. The Indian trees are markedly inferior in height growth, a whole quality class lower. In point of overbark girth they are superior but this is offset by the much greater thickness of the bark, bark per cent. being 53 as against 30 in the Burma teak. Total volumes and mean annual increment are inferior in the Indian trees. Form of the Indian trees is very definitely poor and must be inherent, for the immediately adjoining Burma teak are of excellent form. Almost all stems are wavy, very few being absolutely straight and a fair proportion (12 per cent.) had bent over towards the south-east, *i.e.,* down the slope, and towards the prevailing wind. Burma teak grown locally are of very straight growth. Table 2 summarizes vegetative differences between the two varieties.

[1]Average at Southern Watershed Reserve.

TABLE 2.—VEGETATIVE DIFFERENCES BETWEEN INDIAN AND BURMA TEAK

Character	Indian Teak	Burma Teak
1. *Length of internodes—*		
Young stem up to 7 ft.	4 in.—6 in.	8 in.—13 in.
Branches	2½ in.—3 in.	2½ in.—4½ in.
2. Stem	Wavy	Straight.
3. Small branchlets	Many	Few.
4. Leaf surface	Shiny and smooth ..	Rough.
5. LEAF SIZE—		
Sun leaves—		
Petiole	1½ in.	1 in.
Lamine	9 in.—10½ in. × 4½ in.—6 in.	20 in.—24 in. × 15 in.—16 in.
Shade leaves—		
Petiole	3/4 in.	Nil.
Lamina	9 in.—13 in. × 6 in.—8 in.	20 in.—24 in. × 12 in.—15 in.
6. Flush leaves	Green	Deep red purple.
7. Flowers and fruit	Not examined	Not examined.

An apparent greater density of the Indian teak is to be inferred from a noticeably greater hardness. It is not yet possible to test relative durability as hardly any heartwood is as yet being formed.

The marked vegetative differences between the teak of India and Burma referred to in the Silviculturist's letter are thus established, and it is evident that the two belong to markedly different "races." These are not recognised botanically even as varieties, presumably because there is no variation in the flowers.

Race in trees has long been recognised in Europe, where trees such as larch and pine in different localities are known to be of different growth and form—hereditary differences which persist in a new environment. In Java where much work has been done on teak, several races of teak are recognised. Experimental plots have been laid out to compare them. Seven strains in all were compared: from Malabar, Godavari and the Javanese. Indian forms were all found to be of bad shape with heavy branching, and those from the north of India showed inferior height growth. Siam and Burma teak races were found to be the best both in form and height growth. Each race could be easily distinguished by vegetative differences such as those noted in Trinidad.

The indications certainly are that Trinidad luckily obtained one of the best races of teak in the preliminary trials. Had the first importation of seed been made from northern India, teak in Trinidad might well have been judged a failure. Others in tropical America who contemplate trials with teak should bear this in mind. Best results will be obtained from planting in Burma or Siam, and seed should be obtained only from a reliable source. There are a number of old teak trees in the Botanic Gardens in St. Vincent, which appear to belong to an Indian race. When experimenting with a view to starting afforestation two years ago, the Agricultural Department of St. Vincent imported planting stock (of Burmese race) from Trinidad instead of collecting seed from these trees. The young trees show considerable promise and are probably superior to those which would have been raised from the trees already growing in St. Vincent.

—*The Caribbean Forester*, Vol. 4, No. 3, dated April, 1943

OPPORTUNITIES IN FORESTRY

HARDY L. SHIRLEY[1]

In spite of recent pessimism among foresters as to the future of wood, it still remains a basic and indispensable raw material for military and industrial uses alike. Sustained yield management of our forests to meet not only our own needs but those of other countries is one of the essentials for the establishment of an enduring, people's peace. This will require some measure of public control, in which local communities as well as higher levels of government should participate; technical skill; and recognition of the economic interdependence of the nations of the world. An immense field of service lies before American foresters who, more truly than those of any other nation, will be available and trained for leadership in organizing and manning the forest and wood-using division of a great world economic federation.

War undeniably stimulates scientific and professional activity in many fields. New synthetic products are rushed from the chemist's laboratory into mass production; new engineering processes deemed too expensive to develop in peace find immediate adoption in war; and international pacts such as the Atlantic Charter are readily assented to as solemn obligations to the post-war world.

What opportunities does war bring foresters? Is ours a luxury profession to be laid on the shelf for the duration? Have we somehow mufled opportunities? Will we have a big job in the post-war period? Our country desperately needs forest products of all sorts and in large quantities. Our job as foresters is to help make sure first that these needs are met, and second that in meeting them the long-term productivity of the forest resources be impaired as little as possible. And this job must extend through the reconstruction period. But lacking professional control over forest industries and factors influencing production on the one hand, and control over most of the commercial forest lands on the other, we are ill-equipped to discharge this obligation. Consequently, we find our services restricted mainly to supplying data on such strategic timber as airplane spruce and birch veneer, to developing wood plastics, designing and testing crates and boxes, and other strictly technical jobs. We do not find ourselves mobilized with the forest-products industries to produce wood in the sense that specialists in agronomy, animal husbandry, and soils are mobilized with farmers to produce food.

WOOD STILL IMPORTANT

Our faith in the future of wood, and especially of sawtimber, was shaken by many ugly facts and by the skill with which these facts were exploited by advocates of wood substitutes. Foremost was the chronic depression of the lumber industry from 1929 to 1940, brought on in part by a decline in per capita lumber consumption, in part by increased use of substitutes and by other causes. A receptive ear was also lent to architects and underwriters who dwelt on the inherent disadvantages of wood, its inflammability, susceptibility to decay, shrinking and swelling, and weaknesses at joints. The involved steps in wood working—sawing, planning, milling, turning,

1 Director, Allegheny Forest Experiment Station, Philadelphia, Pa.

In 1935 Mr. Shirley visited central Europe and observed the methods by which Nazi Germany controlled forest production, as contrasted with the methods used in democratic Switzerland, Denmark, and Sweden. Later in 1937, on a trip to Puerto Rico he observed the pressure of the wood-starved population on the remnants of forest and scrub growth and the relative adundance of forest products available on the island of Trinidad. These experiences, together with his reading and thinking on the international aspects of forestry, provide the background for this article.

The viewpoint which he expresses is entirely personal and is presented to stimulate thought and discussion.

sanding, fastening, and finishing—were contrasted with the simple processes of moulding plastic materials and pressing sheet metal. The future was hailed as the day of the cellulose engineer whose achievements would relegate foresters to tending successive crops of rapidly growing poplar sprouts managed on rotations of ten years or less. It was reputed that the timber crops from other forest land would be of such insignificant value that owners might manage it however they saw fit. The allegation that our country had a super-abundance of forest land and timber growth confronted us from many sources.

But there is a bright side also. A great industrial civilization can be maintained only upon a wealth of cheap natural resources. Wood is one of our major raw materials renewable through growth, and the extent of its use is limited mainly by its availability and cost. The many advantages of wood include its abundance, cheapness, wide range of technical qualities among and within species, its strength and stiffness in proportion to its weight, low heat and electrical conductivity, the ease with which it can be fabricated with simple tools which ordinary workmen understand how to use, its high durability when protected from dampness and insects, and its resistance to corrosion in air and in fresh and salt water. Aside from speciality uses, wood in its natural state has a host of uses and a volume of use unlikely to be displaced by the products of the chemical industry, so long as timber of large size and suitable quality remains available. Today's tremendous demands for fuelwood, poles, piling, cooperage, lumber, plywood, and veneer reassure our faith in wood as an inherently useful raw material never too abundant for a modern industrial nation.

Timber of large sizes and high quality has always played a prominent part in our national defense. In the early days log block houses and stockades formed the bulwark of settlers' protection, and wooden fighting ships established our right to world commerce. As early as 1799 concern over an adequate supply of oak for frigates led to our first public forest reserves. With the advent of ironclads these reserves were forgotten, yet today high quality oak for keels, ribs, and planking of subchasers, mine sweepers, and patrol boats is badly needed and difficult to supply. Other vital demands requiring high-quality timber include hickory for skis, oak for truck bodies, black walnut and black cherry for gun stocks, beech for beds and cots, ash for handles and snowshoes, spruce and yellow poplar struts and birch, maple, and gum veneers for airplanes and gliders, Douglas fir and southern pine for ship planking, special plywood for life boats, invasion craft, and patrol torpedo boats.

As the war places a premium on metals, wood is being used in new ways as an alternate material. Modern timber connectors have immeasurably increased the strength of wood joints, thereby making possible the fabrication of long trusses and struts needed in bridges and towers. Laminated wooden arches possess much of the strength and fitness of steel for supporting warehouse and factory roofs. Wood impregnated with resin-forming substances, heated and compressed, gives rise to compreg, having far greater strength, density, hardness, and gloss than natural wood. Wood impregnated with urea formaldehyde becomes a thermo-setting plastic that retains many desirable wood properties. All these uses, new and old, require high quality logs and lumber as basic material.

Chemical uses also have grown apace. *Fortune* magazine in three recent articles heralds a new age of wood. Dr. Glesinger has emphasized how wood literally provides motive power and greases the wheels of the Nazi war machine. We Americans are not lagging behind the Germans in developing new products through wood chemistry. The prosaic end product of wood distillation, charcoal, in the chemist's hands becomes activated carbon for gas masks and water filters. The wood pulp of the ages has been transformed into new rayons, cellophanes, and plastics. Hydrolysis of wood yields sugar for stock feed and alcohol, and the new hydrogenation of wood yields motor fuel, many alcohols, and lubricants. Most of these chemical techniques are not new in themselves. What is new is applying them to wood. Meanwhile, the chemical secrets of lignum and to a large extent of cellulose remain obscure, and a typical chemistry of wood is yet to be developed. But of all the new uses named or in prospect, none seem likely to approach in volume that required by the construction industry.

Forest Resources in the Post-War World

American forestry in the future will be influenced tremendously by America's old and new wood-using industries. It is likely to be influenced even more by the economic organization of the post-war world. Obviously, no one can predict what this will be like, but foresters as citizens and as members of professional and other organizations have a right to speculate on the peace and to influence its character. When this people's war brings a people's victory, it must bring a people's peace. None other will be stable. Isolationist policies and the extreme economic nationalism they breed offer no recourse for correcting real or imagined international injustices except war. The seed of Germany's vengeful new order were soon on a bed of insecurity created by economic nationalism within and without her borders. To lay complete responsibility for to-day's war upon the leaders in Japan, Italy, and Germany is grossly to over-estimate the importance of a few wilful men.

The world is in the throes of a revolution comparable in significance with the industrial revolution. Just as factory production crushed home handicraft production, so now state totalitarian production is crushing private industrial production in all German-dominated territories. To avoid defeat, Britain and we too have resorted to a large degree of state control over production. The small, resource-poor countries are at distinct disadvantage in a world economy dominated by large totalitarian states. Their political independence requires free access to world resources. Americans have been quick to recognize our stake in Sumatra's rubber, Malaya's tin, and Java's quinine. We now feel a great stake in the freedom of the commerce that transports Brazil's coffee to our breakfast tables. But if we have vital interest in the products of other countries, may not they have an equal claim to the products from our country? If so, have not Europe and Asia a legitimate interest in the forest products of our hemisphere?

The release that state control brings from the restraints of monopolistic industry on the one hand and from competitive waste on the other has tremendously increased production. Government gains great power and prestige thereby. To the extent that government remains answerable to the will of enlightened people,

the people themselves gain great economic advantage. But bureaucratic inefficiencies or political irresponsibility can quickly dissipate these advantages. The struggles throughout the ages of mankind of all races, colors, and creeds, re-enacted today by heroic people throughout Nazi-occupied Europe, demonstrate that no stable government or world organization can be based on a master race (Herrenvolk) dominating subservient slaves (Hilfvolk). The great task for the people's peace is to make sure that the people intelligently control their power within nations and in the international sphere to promote permanent peace and prosperity. In this great endeavor, foresters have no small part of play.

LOCAL COMMUNITIES AND PUBLIC REGULATION

Arthur Morgan has stated that it is only in the local community that a man is known for what he really is. The community therefore offers the ideal training ground for responsible public leadership. In forestry, the community is the center of the working circle which forms the basic unit for management policy. Public regulation of timber cutting on private land has recently been discussed widely and the relative merits of regulation at the state and federal levels hotly debated. Few attempts have been made to devise regulation patterns to fit specific local conditions where the effects for good or ill will be most keenly felt. Here regulation means far more than the proposal by the U. S. Forest Service to establish some broad floor beneath which forest cutting practices must not go. Community regulation includes this, but it also involves adjusting wood use to forest productive capacity of the community or county. It becomes not a task for public foresters alone but for timberland owners, woods workers, industrial managers, and the community authorities, who must decide how their forest land can best be made and held highly productive. It is they who reap first hand the benefits of stable markets for forest products, steady jobs in the woods and wood-using industries, and continued prosperity to the local community.

Some communities have built their economy around chemical utilization of wood. These do not need to grow saw-timber. Others have developed their economy around lumber, veneer, and plywood. These require long rotation forestry, preferably with satisfactory markets for the intermediate products. Where two such industries happen to be located in the same community, they can supplement one another so as to get ideal utilization. On the other hand, they can and frequenly do compete with one another in such a way that the lumber and plywood industries soon become completely deprived of raw material. Wherever two industries are competing for the products from forest land, the one that can use timber in the smallest sizes will inevitably drive the other out of business, unless some form of control is enforced. Insuring reproduction of forests is only the first step towards adequate regulation. Far more important is the maintenance of growing stock properly distributed by size classes.

If the community becomes the unit for forest regulation, then the forester, like public health specialist, must think first of community welfare and second of individual's desires. Forestry then will truly become a great public-service profession in which the forester plays a central role in reconciling the needs of timber owners,

workers, and industrialists to the welfare of a community. This will require on the part of foresters not only sound technical training in their own specialities, but also imagination, diplomacy, and statesmanship.

But the community and the county are but links that make up the state and our nation. Plans and regulations worked out for individual communities and counties will require adjustments so as to insure a balanced forest economy for the forest region, for the state, and for our entire country. From local forest statesmen schooled in recognizing public needs must arise those capable of planning and integrating forest economy at the higher levels, so that our nation as a whole reaps overall benefits commensurate with the capacity of the resource to provide these benefits. It is at the state and national levels, more clearly than at the community level, that attention must be focused on such overall benefits as soil protection, watershed protection, flood control, permanence of navigation, protection of wildlife, and protection of unique recreational areas.

All Nations Economically Interdependent

The United States consumes more wood than any other country, two-fifths of the total world use. We are the second largest exporter and second largest importer of wood. We are therefore concerned over both the world supply of wood and the world market for forest products. We control some 630 million of the world's 7,487 million acres of forest land. Economic interdependence in the post-war world will require worldwide planning and co-ordination if the needs of all countries for forest products and markets are to be met. This will create a demand for highly trained foresters, of worldwide outlook who can supply technical guidance and control to a world economic federation. In such men will reside the final responsibility for reconciling world needs with productive capacity and for recommending adjustments within and between individual countries. We cannot expect such a plenary forest authority to appear full blown upon the cessation of hostilities. But if small countries with meager resources are to remain autonomous, some device for regulating the use and distribution of world resources must be provided, and this will surely encompass such basic necessities as forest products and food.

What are some of the first steps in an action program designed to exploit fully the world's forest resources? Clearly developing sustained-yield working circles about each important forest community is a basic step. This will require local surveys to determine timber volume, growth, and drain. Forest policies and plans must next be formulated. These require integration and articulation at the regional state, and national level. An early, worldwide forest survey is particularly needed as a basis for equable trade adjustments among nations. The planning needed is a stupendous job in itself, but carrying these plans into action is still a greater task.

From the very beginning of forestry in America, our profession has struggled with the broad problems of resource management on a national scale. Through our assistance with agricultural planning, we have gained considerable experience in adjusting local economy to national needs. This process need but be repeated on a

worldwide basis, covering all major resources, to attain the objectives set forth by such prominent public men as Henry Wallace, Cordell Hull, Sumner Welles, and Wendell Willkie. Wood in abundance will patently be needed to reconstruct our own dwellings and industries as well as those in the war-torn Eastern Hemisphere. As people throughout the world come to realize that the quality of their homes, the safety of their railroads and the raw materials for countless essential commodities depend directly upon the productivity of the forests, the demand for good forest practice will be universal.

American foresters more truly than those of any other great nation will be available and trained for assuming positions of leadership in the tasks of organizing and manning the forest and wood-using division of a great world economic federation. This job encompasses vast land areas, and affects directly many peoples. We can do much to build a permanent foundation under a world peace structure. An immense field for service lies before us.

—*Journal of Forestry*, Vol. 41, No. 2, dated February, 1943.